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Atikokan TGS Aquatic Studies, 1981 to 1988.
III. Plankton and Macrophytes

Report No 89-138-K

J.K. Kwik and T.G. Dunstall
Biological Research Section
Chemical Research Department

ABSTRACT

The results of the primary production, phytoplankton, zooplankton and macrophyte studies conducted as part of the postoperational aquatic studies at Atikokan TGS in 1987 and 1988 are presented in this report. They are compared to data collected during the preoperational (1981-1983) and commissioning (1985) phases, and 1986 postoperational studies, to identify changes in components of the aquatic environment which may be related to the construction or operation of the generating station. Primary production was more uniform throughout the water circuit following establishment of the cooling circuit. Differences in the phytoplankton data among study years may be due to natural annual variation and/or artifacts of infrequent sampling rather than station operation. Comparison of zooplankton data collected during the pre- and postoperational years suggests that station operation has not resulted in any obvious changes in the zooplankton that can be distinguished from year-to-year variation. Water drawdown during the preoperational period resulted in increased growth of *E. canadensis* and the concurrent disappearance of water lilies from Snow Lake. There has been a gradual increase in the distribution of the macrophytes since the stabilization of water levels in the cooling circuit in 1982. In addition, their density has increased steadily since the station started operating.

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EXECUTIVE SUMMARY

Atikokan TGS Aquatic Studies, 1981 to 1988. III. Plankton and Macrophytes

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Biological Research Section
Chemical Research Department

Preoperational aquatic studies were conducted at Atikokan TGS from 1981 to 1983, followed by one year of commissioning studies in 1985. The postoperational studies were conducted from 1986 to 1988. The results of the primary production, phytoplankton, zooplankton and macrophyte studies conducted in 1987 and 1988 are presented in this report and compared to data collected during the preoperational and commissioning years. The studies were requested by Environmental Studies and Assessments Department, of Design and Development Division - Generation, on behalf of Atikokan Engineering. The purpose of the studies is to identify changes in components of the aquatic environment which may be related to the construction or operation of the generating station.

The study area consists of five lakes within the cooling circuit: Snow, Icy, Abie, Marmion and Moose Lakes. Two locations outside of the cooling circuit, Slush Lake and Lower Seine Bay on Marmion Lake, were included as controls.

Prior to the establishment of the Atikokan TGS cooling circuit, primary production levels in Snow, Icy and Abie Lakes were higher than in Marmion. Following the implementation of the cooling circuit and mixing of the water of the cooling circuit, primary production levels in Snow, Icy and Abie Lakes had decreased and were more similar to levels in Marmion Lake where primary production had increased. Primary production levels in Slush Lake in the pre- and postoperational studies were comparable. Circulation of nutrients would appear to account for the decreases in primary production observed in Snow, Icy and Abie Lakes and the concomitant increases observed for the Marmion Lake locations in 1987-1988.

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The diatoms and flagellates were the most important phytoplankton in the study area in both the pre- and postoperational studies. Although the spatial distribution of the phytoplankton was quite different in 1987 than it was in 1983, there were some similarities to the 1981 distribution. Generally, phytoplankton biomass appears to have increased since 1981. In addition, some of the more common phytoplankton taxa appear to be more widespread in 1987 than they were in 1981. However, these apparent differences may be part of natural annual variation and/or an artifact of infrequent sampling rather than a station operation effect, since the differences are not distinct between pre- and postoperational years.

The most common rotifers and crustacean zooplankton present in the study area were similar in 1981, 1983 and 1987. However, the relative abundance of some of these species differed among years. Comparison of the three-years of data suggests that the densities of the zooplankton have not increased since the implementation of the cooling circuit. As in the case of the phytoplankton, the spatial distribution of the rotifers in 1987 was more similar to their 1981 spatial distribution than that of 1983. The spatial distribution of the crustacean zooplankton had some similarities in all three years. Comparison of the zooplankton data collected since 1981 suggests that station operation has not resulted in any obvious changes in the zooplankton of the study area that can be distinguished from year-to-year variation.

Effects of construction associated with the Atikokan TGS cooling circuit on the macrophytes included the increased abundance of *E. canadensis* and the concomitant disappearance of the water lilies from Snow Lake following the 1981-1982 water drawdown. Lowering of the water level in Icy Lake in 1982 resulted in an increase in the density of the submergents in the centre of the West bay between 1981 and 1982. In 1983, lowered water levels as a result of reduced flow into this bay may have caused extensive winterkill resulting in a marked reduction in the density of the submergents.

There has been a gradual increase in the distribution of the macrophytes in the cooling circuit lakes since the stabilization of the water levels in 1982. In addition, since the operation of the station in 1985, there has been an increase in the density of the macrophytes especially in Snow, Icy and Abie Lakes. Large patches of heavy growth of pondweeds, which were first observed as small patches in 1985, were found along the cooling circuit in Icy and Abie Lakes wherever suitable depth and substrate occurred. It is suggested that increased siltation observed in Snow, Icy and Abie Lakes is related to the increased distribution and density of macrophytes in these Lakes.

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	METHODS	3
2.1	Primary Production	3
2.2	Phytoplankton	4
2.3	Zooplankton	4
2.4	Macrophytes	5
3.0	RESULTS AND DISCUSSION	5
3.1	Primary Production	5
3.1.1	Comparison of 1983-1984 and 1987-1988 Data	5
3.1.2	Spatial Comparison	8
3.1.3	Seasonal Trends	11
3.1.4	Overview	11
3.2	Phytoplankton	14
3.2.1	Species Composition	14
3.2.2	Seasonal Distribution	16
3.2.3	Spatial Distribution	17
3.2.4	Comparison of 1981, 1982, 1983 and 1987 Data	21
3.2.5	Overview	21
3.3	Zooplankton	21
3.3.1	Rotifers	23
3.3.1.1	Species Composition	23
3.3.1.2	Seasonal Distribution	25
3.3.1.3	Spatial Distribution	25
3.3.1.4	Comparison of 1981, 1982, 1983 and 1987 Data	29
3.3.2	Crustacean Zooplankton	29
3.3.2.1	Species Composition	29
3.3.2.2	Seasonal Distribution	32
3.3.2.3	Spatial Distribution	35
3.3.2.4	Comparison of 1981, 1982, 1983 and 1987 Data	35
3.3.3	Overview	35
3.4	Macrophytes	38
3.4.1	Species Composition	38
3.4.2	Distribution and Abundance of Macrophytes	40
3.4.3	Overview	66
4.0	CONCLUSIONS	67

TABLE OF CONTENTS (Con't)

		Page
5.0 ACKNOWLEDGMENTS		68
LITERATURE CITED		69
APPENDIX	I	A1-1
	II	A2-1
	III	A3-1
	IV	A4-1
	V	A5-1
	VI	A6-1
DISTRIBUTION		last page

LIST OF TABLES

		Page
3.1.1-1	Multiple Range Comparison of Mean Alkalinities (mg/L) for Primary Production Locations During 1983-84 and 1987-88	6
3.1.1-2	Trophic Classification of Atikokan Lakes Based on Phytoplankton Primary Production	9
3.1.1-3	Multiple Range Comparison of Mean Primary Production Values (Log Transformed; mg Carbon/m^3/h) for Locations sampled in 1983-84 and 1987-88	10
3.1.3-1	Multiple Range Comparison of Mean Primary Production Values (Log Transformed; mg C/m^3/h) for Months sampled in 1983-84 and 1987-88	13
3.2-1	Species Composition and Annual Mean Biomass (Mg/M*/M*/M) of Phytoplankton Collected Monthly in the Atikokan GS Study Area From May to October 1987	15
3.2.3-1	May to October Mean Phytoplankton Densities (Mg/m^3) 1981, 1983 and 1987, Atikokan TGS	20
3.2.4-1	Comparison of Phytoplankton Mean Biomass (Mg/m^3) for May/Early June, August and October, 1981, 1982, 1983 and 1987, Atikokan TGS Study Area	22
3.3.1-1	Species Composition and Mean Densities (No/M*/M*/M) of Rotifers Collected Monthly in The Atikokan GS Study Area From May to October 1987	24
3.3.1-2	May to October Mean Densities of Rotifers (No/m^3) 1981, 1983 and 1987, Atikokan TGS	28
3.3.1-3	Comparison of Rotifer Densities (No/m^3) for May/Early June, August and October, 1981, 1982, 1983 and 1987, Atikokan TGS Study Area	30
3.3.2-1	Species Composition and Mean Densities (No/M*/M*/M) of Crustacean Zooplankton Collected Monthly in the Atikokan GS Study Area From May to October 1987	31
3.3.2-2	May to October Mean Crustacean Zooplankton Densities (No/m^3) 1981, 1983 and 1987, Atikokan TGS	36
3.3.2-3	Comparison of Crustacean Zooplankton (No/m^3) for May/Early June, August and October, 1981, 1982, 1983 and 1987, Atikokan TGS Study Area	37
3.4.1-1	Macrophyte Species Observed in The Atikokan Study Lakes From 1981 Through 1986	39

LIST OF FIGURES

		Page
1.1	Macrophyte Sampling Locations	2
3.1.1-1	Comparison of Alkalinities for Atikokan Lakes before (1983-84) and following (1987-88) Generating Station Operation.	7
3.1.3-1	Temporal Patterns in Primary Production (Mean ± 1 S.D.) for (A) Slush Lake, (B) Marmion Lake Locations and (C) Snow, Icy and Abie Lakes During Pre- (1983-84) and Post-Operational (1987-88) Study Period	12
	Phytoplankton Densities (Mg/m^3)	18
3.2.2-1	Snow Lake, 1987	
3.2.2-2	Icy Lake, 1987	
3.2.2-3	Abie Lake, 1987	
3.2.2-4	Slush Lake, 1987	
	Phytoplankton Densities (Mg/m^3)	19
3.2.2-5	Marmion South, 1987	
3.2.2-6	Marmion North, 1987	
3.2.2-7	Anderson Dam, 1987	
3.2.2-8	Moose Lake, 1987	
	Rotifer Densities (No/m^3)	26
3.3.1-1	Snow Lake, 1987	
3.3.1-2	Icy Lake, 1987	
3.3.1-3	Abie Lake, 1987	
3.3.1-4	Slush Lake, 1987	
	Rotifer Densities (No/m^3)	27
3.3.1-5	Marmion South, 1987	
3.3.1-6	Marmion North, 1987	
3.3.1-7	Anderson Dam, 1987	
3.3.1-8	Moose Lake, 1987	
	Crustacean Zooplankton Densities (No/m^3)	33
3.3.2-1	Snow Lake, 1987	
3.3.2-2	Icy Lake, 1987	
3.3.2-3	Abie Lake, 1987	
3.3.2-4	Slush Lake, 1987	
	Crustacean Zooplankton Densities (No/m^3)	34
3.3.2-5	Marmion South, 1987	
3.3.2-6	Marmion North, 1987	
3.3.2-7	Anderson Dam, 1987	
3.3.2-8	Moose Lake, 1987	
3.4.2-1	Distribution of Macrophytes in Snow Lake in 1987	42

LIST OF FIGURES (Con't)

		Page
3.4.2-2	Distribution of Macrophytes in Snow Lake in 1988	43
3.4.2-3	Distribution of Macrophytes Along West Shore of Snow Lake in 1987 and 1988	44
3.4.2-4	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) Along Western Shore of Snow Lake, 1987	45
3.4.2-5	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) Along Western Shore of Snow Lake, 1988	46
3.4.2-6	Distribution of Macrophytes in West Bay of Icy Lake in 1987	48
3.4.2-7	Distribution of Macrophytes in West Bay of Icy Lake in 1988	49
3.4.2-8	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) in West Bay of Icy Lake, 1987	50
3.4.2-9	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) in West Bay of Icy Lake, 1988	51
3.4.2-10	Distribution of Macrophytes in East Bay of Icy Lake in 1987	52
3.4.2-11	Distribution of Macrophytes in East Bay of Icy Lake in 1988	53
3.4.2-12	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Species () on Transect Segments (├─┤) in East Bay of Icy Lake, 1987	54
3.4.2-13	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Species () on Transect Segments (├─┤) in East Bay of Icy Lake, 1988	55

LIST OF FIGURES (Con't)

		Page
3.4.2-14	Distribution of Macrophytes in East Basin of Abie Lake in 1987	57
3.4.2-15	Distribution of Macrophytes in East Basin of Abie Lake in 1988	58
3.4.2-16	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) in East Basin of Abie Lake, 1987 and 1988	59
3.4.2-17	Distribution of Macrophytes in Slush lake in 1987 and 1988	60
3.4.2-18	Distribution of Macrophytes in Marmion Lake Near Abie Lake in 1987 and 1988	62
3.4.2-19	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) in Marmion Lake Near Abie Lake, 1987 and 1988	63
3.4.2-20	Distribution of Macrophytes in Marmion Lake Near Anderson Dam in 1987 and 1988	64
3.4.2-21	Dominant Submergent Macrophytes, Percent Cover of Submergent Macrophytes, and Number of Submergent Macrophyte Species () on Transect Segments (├─┤) in Marmion Lake Near Anderson Dam, 1987 and 1988	65

LIST OF APPENDICES

Appendix		Page
1	Primary Production - Atikokan 1987-1988	A1-1
2	May - October 1987 Atikokan Phytoplankton Biomass (Mg/m^3)	A2-1
3	May - October 1987 Atikokan Zooplankton Densities (No/m^3)	A3-1
4	Scientific and Common Names of Macrophytes Cited in the Text (from Fassett 1975)	A4-1
5	Macrophyte Species Observed Along Transects Selected for Special Study, 1987:	A5-1
	Snow Lake in 1987	A5-2
	West Bay of Icy Lake in 1987	A5-3
	East Bay of Icy Lake in 1987	A5-4
	Abie Lake in 1987	A5-5
	Marmion Lake near Abie in 1987	A5-6
	Marmion Lake at Anderson Dam in 1987	A5-7
6	Macrophyte Species Observed Along Transects Selected for Special Study, 1988:	A6-1
	Snow Lake in 1988	A6-2
	West Bay of Icy Lake in 1988	A6-3
	East Bay of Icy Lake in 1988	A6-4
	Abie Lake in 1988	A6-5
	Marmion Lake near Abie in 1988	A6-6
	Marmion Lake at Anderson Dam in 1988	A6-7

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To: Dr. W.R. Effer
Manager
Environmental Studies and Assessment Department
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ATIKOKAN TGS AQUATIC STUDIES, 1981 TO 1988. III. PLANKTON AND MACROPHYTES

1.0 INTRODUCTION

Atikokan TGS is a thermal generating station consisting of one 200 MW lignite-fired unit. The condenser cooling water for Atikokan TGS is drawn from the 10-m depth of Moose Lake and discharged at the surface of Snow Lake. The design delta T across the station for the summer months is 11.3°C. The discharge water circulates through Snow, Icy, Abie and Marmion Lakes and back into Moose Lake (Figure 1.1). Within the cooling circuit, Snow and Icy Lakes are ice-free year-round while Abie Lake only has ice cover in the early part of the winter.

The in-service date for the unit was November 14, 1985. Through most of 1986, the station operated from 0600 h to 2200 h, five-days a week and was shutdown on the weekends. In December 1986, twenty-four hour operation was initiated. Subsequently, non-weekend shutdowns were sporadic and extended beyond 10 days during the following periods: March 12 - 29, 1987, September 5 - October 7, 1987, and March 13 - April 3, 1988, June 17 - July 1, 1988, and September 3 - October 2, 1988.

Preoperational aquatic studies at Atikokan TGS were conducted from 1981 to 1983. Commissioning studies were conducted in 1985 and postoperational studies were conducted from 1986 to 1988. The results of the 1987 primary production, phytoplankton and zooplankton surveys and the 1987 and 1988 macrophyte surveys are presented in this report. Results of the studies conducted from 1981 through 1986 are presented in Haymes (1983, 1984, 1985a, 1985b, and 1986), and Haymes and Kwik (1987 and 1988). The studies were requested by Environmental Studies and Assessments Department of Design and Development Division - Generation on behalf of Atikokan Engineering. The

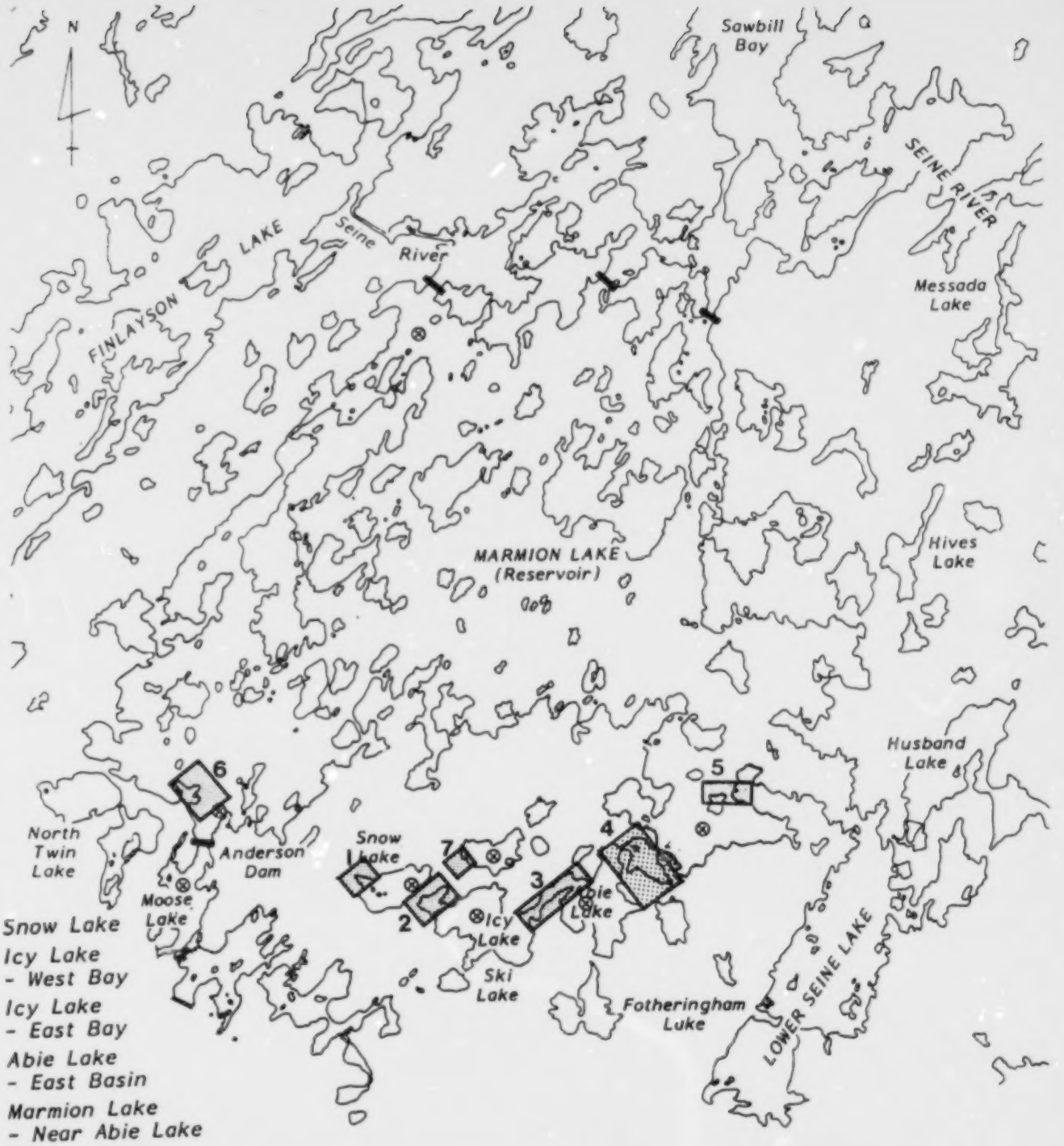

FIGURE 1.1
MACROPHYTE SAMPLING LOCATIONS

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purpose of the studies is to identify changes in components of the aquatic environment which may be related to the construction or operation of the generating station.

The study area consists of five lakes within the cooling circuit: Snow, Icy, Abie, Marmion and Moose Lakes. Two locations outside of the cooling circuit, Slush Lake and Lower Seine Bay on Marmion Lake, were included as control sites.

2.0 METHODS

2.1 Primary Production

Primary production was determined by the carbon-14 method of Steemann-Neilson (1952). Complementary samples were taken at each study location for water chemistry and plankton analyses. Measurements for primary production were made on six occasions during May to October and once during the winter in both the preoperational (1983-1984) and postoperational (1987-1988) study periods. Moose Lake was included in the 1987-1988 study although it was not included in the earlier study.

Samples were taken from the 0 to 3-m depth with a 3-m polyvinyl chloride (PVC) tube (2.5-cm I.D.) equipped with a self-closing butterfly valve. Samples were dispensed through the bottom spout via Tygon tubing into 2-L amber polyethylene bottles which were stored in coolers, maintained at lakewater temperature, during transit. Triplicate 125-mL glass stoppered bottles were filled with sample water from each lake location within 3 h of collection. A composite sample, prepared by mixing 100 mL of lakewater from each location, was dispensed into 3 bottles that were wrapped in aluminum foil (i.e. dark bottles). All equipment was rinsed thoroughly before sample collection or transfer.

Sample bottles were placed in a water bath incubator maintained at ambient lakewater temperature ($\pm$ 2C^{o}) and were illuminated with 4,300$\pm$ 400 lux from a bank of ten 20 W fluorescent lamps (Dunstall 1977). After a 0.5 h adaptation period, 2 to 4 μCi of sodium (^{14}C) bicarbonate was added to each bottle. After thorough shaking, two 1-mL aliquots were removed from each bottle for determination of initial radioactivity, and bottles were returned to the incubator.

Following a 2 to 3-h incubation period, duplicate 20 mL aliquots from each bottle were filtered on HA 0.45 μ-m Millipore filters (25-mm dia. gridless). The ^{14}C retained by the cellular fraction, which was generally one to two orders of magnitude above background radioactivity levels, was measured. Filtrates were collected, acidified with HCl to pH 3.5, aerated vigorously for 20 min, and 1-mL aliquots were taken for the measurement of soluble ^{14}C organic compounds released by phytoplankton cells (Fogg 1971). Extracellular release was low, averaging 4.6 $\pm$ 6.1% (mean $\pm$ 1 S.D.; n = 128) of total carbon fixed, with no consistent pattern in levels of release apparent among locations.

Radioactivity measurements were made with a Packard Tri-Carb 300 Scintillation Counter. Filters and aqueous samples placed in PCS II scintillation cocktail (Amersham) formed homogeneous solutions. Counts (dpm) retained by filters or present in the filtrates were corrected for background radioactivity levels of 31 dpm per mL. The experiment on June 25-26, 1988, was unsuccessful, due to an absence of $H^{14}CO_3$ in the stock solution.

Radioactive counts of the two filters from each replicate bottle were averaged. Primary production (P) expressed as mg C fixed/ m^3/h was determined for each bottle as follows:

$$P = \frac{\text{Cellular } ^{14}C \text{ in Filters (dpm/mL)}}{\text{Total } ^{14}C \text{ Added (dpm/mL)}} \times \text{DIC (mg C/m}^3\text{)} \times \frac{60}{t} \times f$$

where DIC is the dissolved inorganic carbon content of the samples, determined by the method of Saunders et al. (1962), t is the incubation time in min and f is the isotopic discrimination factor (^{14}C versus ^{12}C - 1.06). Excreted carbon was determined by using filtrate dpm values in place of filter dpm values in the above equation. Total primary production was the sum of the cellular and excreted carbon fractions.

2.2 Phytoplankton

Phytoplankton sampling locations are indicated on Figure 1.1. Phytoplankton samples were collected from Snow Lake, Icy Lake, Abie Lake, Slush Lake and Marmion Lake at Marmion South, Marmion North and Anderson Dam with a 3-m PVC tube (2.5-cm I.D) equipped with a self-closing butterfly valve, monthly from May through October of 1987. Samples were preserved in Lugol's Iodine. Data are presented as mg m^{-3}. Sampling was similar to that of previous study years.

2.3 Zooplankton

Zooplankton sampling locations are indicated on Figure 1.1. Zooplankton samples were collected at the same locations and times as the phytoplankton samples using a 27-litre Schindler-Patalas trap equipped with 64 μm mesh netting. Samples were collected in the same manner as in previous study years and were integrated samples consisting of duplicate hauls taken at sub-surface (0.5 m) and 2-m intervals to the bottom of the water column. The depths at the plankton sampling locations were 10.0, 11.0 and 9.0 m in Snow, Icy and Abie Lakes, respectively. The depth at the Slush Lake sampling location was 13.0 m. At the Marmion Lake sampling locations the depths were 18.0, 15.0 and 11. 0 m at Marmion South, Marmion North and Anderson Dam, respectively. The depth at the Moose Lake sampling location was 24.0 m. The samples were preserved in 10% alcohol in the field which was replaced with 10% formalin in the laboratory. Data are presented as numbers m^{-3}.

2.4 Macrophytes

Macrophyte surveys were conducted in the northwest bay of Snow Lake, the west and east bays of Icy Lake, the east basin in Abie Lake, Slush Lake, and in Marmion Lake near Abie Lake and at Anderson Dam (Figure 1.1). Within each bay, the transects established in 1982 were cruised by observers in a boat or by a snorkeller who identified the species present and described the vegetation patterns. Voucher specimens of species which were difficult to identify in the field were collected and keyed-out in the laboratory on a later date. As in past years, the surveys were conducted in early August in both 1987 and 1988. The data were used to construct maps showing the distribution of emergent, floating-leafed and submergent vegetation, as well as dominant species and per cent bottom cover.

3.0 RESULTS AND DISCUSSION

3.1 Primary Production

Phytoplankton primary production was measured prior to and following operation of Atikokan TGS as part of the environmental assessment program for this site. Measurements were made on seven occasions during 1983-1984, while the station was still under construction. Six of the locations sampled during this study would become linked to form the cooling water circuit for Atikokan TGS. These sample locations included Snow, Icy and Abie Lakes, Marmion Lake South, Marmion Lake North and Anderson Dam (also part of Marmion Lake). Primary production measurements were also taken for Slush Lake, a headwater lake that flows into Icy Lake but otherwise is physically separate from the other lakes. These same locations and Moose Lake were sampled at similar times of the year during 1987-1988, when the station was operational. Results for the pre- and postoperational primary production studies are presented in this section. Complete data are presented in Appendix 1.

3.1.1 Comparison of 1983-1984 and 1987-1988 Data

Notable changes occurred in the lakes that comprise the cooling water circuit following operation of the generating station. Alterations in alkalinity levels of the lakes, which are used for the determination of dissolved inorganic carbon, are of particular relevance to primary productivity. Prior to station operation, in 1983-1984, significant differences in alkalinity existed between the lakes. Multiple range testing of the means indicated the existence of four lake groups on the basis of alkalinity (Table 3.1.1-1). The results for 1987-1988, shown in the same table, indicate the existence of only two groups, one of which was comprised of all locations within the cooling water circuit (i.e. excluding Slush Lake). Mean alkalinity of the cooling circuit lakes following generating station operation was 38.1 mg/L (S.D. = 2.1; n = 47), comparable to the mean alkalinity of the Marmion Lake locations (38.8 ± 5.6; n = 21) before the station commenced operation (Figure 3.1.1-1). The much larger volume of Marmion Lake would tend to establish the alkalinity level following the circulation of water through all lakes. Thus a substantial reduction in dissolved inorganic carbon levels occurred in Icy, Abie and Snow Lakes following the establishment of the cooling water circuit.

TABLE 3.1.1-1

Multiple Range Comparison of Mean Alkalinities (mg/L) For Primary Production Locations During 1983-84 and 1987-88

1983-84 (1-way ANOVA $f_{(6,42)} = 35.4$; $p < 0.005$)

Slush	Marmion North	Anderson Dam	Marmion South	Snow	Abie	Icy
27.9	38.7	38.8	39.0	51.4	56.3	65.1
*****	**********			**********		****

1987-88 (1-way ANOVA $f_{(7,45)} = 36.5$; $p < 0.005$)

Slush	Marmion North	Marmion South	Snow	Anderson Dam	Moose	Icy	Abie
23.1	36.7	36.8	37.6	38.3	38.4	39.1	39.4
*****	**********						

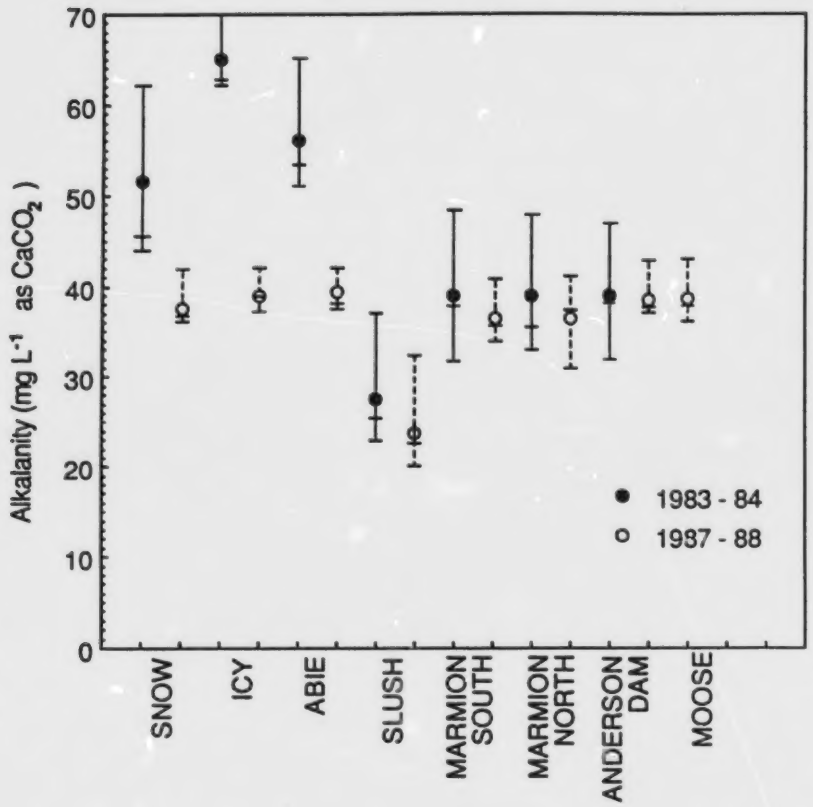

FIGURE 3.1.1-1

COMPARISON OF ALKALINITIES FOR ATIKOKAN LAKES BEFORE (1983-84) AND FOLLOWING (1987-88) GENERATING STATION OPERATION. (Circles Indicate Means - Bars Indicate Median Alkalinities and Range)

Slush Lake, which is isolated from the other locations, had relatively low alkalinity values (24.6 $\pm$ 3.8; n = 12), which were comparable for the two time periods.

Prior to the operation of Atikokan TGS, primary production values typically ranged from 1.7 to 21 mg C/m^3/h for the seven sampling locations. However, higher production (42.8 mg C/m^3/h) did occur in Snow Lake during a bloom of the filamentous blue-green alga, *Anabaena* spp., on September 22, 1983. The biomass of phytoplankton in Snow Lake on this date was about two times higher than the biomass observed at any other locations or on any other sampling dates. During 1983-1984, Snow, Icy and Abie Lakes were all classified as secondary eutrophic on the basis of mean and maximum primary production levels (Vollenweider et al. 1974, Table 3.1.1-2). Such lakes have relatively high annual primary production and occasional algal blooms, such as the *Anabaena* bloom described above. For the remaining locations production decreased in the order: Marmion South, Marmion North and Anderson Dam, and Slush Lake. Measurements at the three Marmion Lake locations indicated that this lake was in transition: i.e. intermediate in status between oligotrophy and mesotrophy (minimum primary production values for mesotrophic lakes is 5 mg C/m^3/h). Slush Lake was considered a borderline oligotrophic lake, with production close to levels typical of transition lakes.

The range in primary production values after the station became operational was 1.0 to 20.0 mg C/m^3/h, comparable to levels observed in 1983-1984. However, primary production in Snow, Icy and Abie Lakes was reduced while Marmion South, Marmion North and Anderson Dam had increased production levels. Production in Moose Lake was comparable to that of Marmion Lake. Within the cooling circuit, primary production levels were similar and all locations except Marmion South were classified as being in transition (Table 3.1.1-2). The Marmion South location barely met the criteria for secondary eutrophy (mean > 10 mg C/m^3/h), with production values only slightly higher than observed for the other locations within the cooling circuit (Table 3.1.1-3). Although a change in the classification of Slush Lake is indicated in Table 3.1.1-2, mean primary production values were comparable before and following operation of the generating station (4.7 versus 5.5 mg C/m^3/h, respectively), confirming its status as a borderline oligotrophic lake.

3.1.2 Spatial Comparison

Three-way (location, month, year) and two-way (location, year) analysis of variance on the primary production data (un-transformed and log-transformed) contained significant ($p < 0.05$) interaction terms. These interactions indicated that a change in primary production had occurred from one study period to the next, although these changes were not consistent for all locations or during all months. One-way analysis of variance and multiple range comparisons of mean primary production levels between sampling locations for 1983 and for 1987 confirmed that the observed changes in production were not consistent between locations (Table 3.1.1-3). In 1983 highest production occurred in Snow, Abie and Icy lakes and lowest production levels occurred in Slush, Marmion North and Anderson Dam. Marmion South had properties that were intermediate between these two groups. In 1987, production in Icy Lake did

TABLE 3.1.1-2

Trophic Classification of Atikokan Lakes
Based on Phytoplankton Primary Production

Trophic Status	Primary Production ($mg/m^3/h$)		Location	
	Mean	Maximum	1983-84	1987-88
Oligotrophic	<5	<15	Slush	Slush
Transition	>5	<15	Anderson Dam Marmion N. Marmion S.	Icy Snow Abie Marmion N. Anderson Dam Moose
Secondary Eutrophic	>10	>15	Icy Abie Snow	Marmion S.

TABLE 3.1.1-3

Multiple Range Comparison of Mean Primary Production Values (Log Transformed; mg Carbon/m^3/h) for Locations Sampled in 1983-84 and 1987-88

1983-84 (1-way ANOVA $f_{(6,140)} = 6.17$; $p < 0.005$)

Slush	Marmion North	Anderson Dam	Marmion South	Icy	Abie	Snow
0.619	0.654	0.692	0.871	0.904	0.941	1.035
**********						
		**********				
			**********			

1987-88 (1-way ANOVA $F_{(7,125)} = 2.09$; $p < 0.05$)

Icy	Slush	Snow	Anderson Dam	Abie	Marmion North	Marmion South	Moose
0.605	0.628	0.810	0.875	0.896	0.898	0.917	0.939
**********							
	**********						

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not differ significantly from that of Slush and Snow Lakes. However, primary productivity in Slush and Snow Lakes was also comparable to all other locations.

3.1.3 Seasonal Trends

Seasonal trends in primary production were similar in both the pre- and postoperational studies at all locations (Figure 3.1.3-1). Production levels were generally low (< 10 mg $C/m^3/h$) from May to August and during the winter (January or March), although slightly higher production values were apparent for Snow, Icy and Abie Lakes during the pre-operational study period. It appears likely that the first sampling dates in both 1983 and 1987 followed the spring diatom pulse that is characteristic of northern shield lakes. Primary production at the time of these pulses tends to be relatively high.

The available data indicated that the highest primary production occurred during September and October at all locations (Table 3.1.3-1). These elevated production levels in the fall are likely to result from the deepening of the thermocline during September and subsequent turnover of the lakes (Haymes 1989a, in draft) resulting in the input of nutrients into the upper water stratum. It was during the fall that the most noticeable differences in pre- and post-operational primary production levels were apparent for lakes within the cooling water circuit. Production values for the Marmion Lake locations at this time of the year increased after the cooling water circuit was established while the reverse situation, decreased production, occurred in Snow, Icy and Abie Lakes.

3.1.4 Overview

Mixing of water within the lakes of the cooling water circuit occurred following station operation as shown for the alkalinity data. This uniformity of distribution would be expected of all chemical parameters. Elevated levels of nutrients, such as inorganic phosphorus and nitrogen, would have been a factor contributing to the abundant algal growth and high primary production in Snow, Icy and Abie Lakes prior to generating station operation. These nutrients, which were locked into the individual lake basins, were dissipated once the cooling water circuit was established. Consequently, the extent of nutrient enrichment associated with the turnover of these lakes in the fall, and the level of primary production supported by this enrichment, would also be reduced. Circulation of nutrients would appear to account for the decreases in primary production observed in these three lakes and the concomitant increases observed for the Marmion Lake locations in 1987-1988.

Although the number of primary production measurements taken during the open water season was limited to six in 1983 and five in 1987, the results indicate that Atikokan TGS has had only a minimal influence on the primary production of Marmion Lake with the trophic status of this lake remaining unchanged. Perhaps the most significant change has been in Snow, Icy and Abie Lakes where production levels have decreased, suggesting that a change in the trophic status of these lakes has occurred.

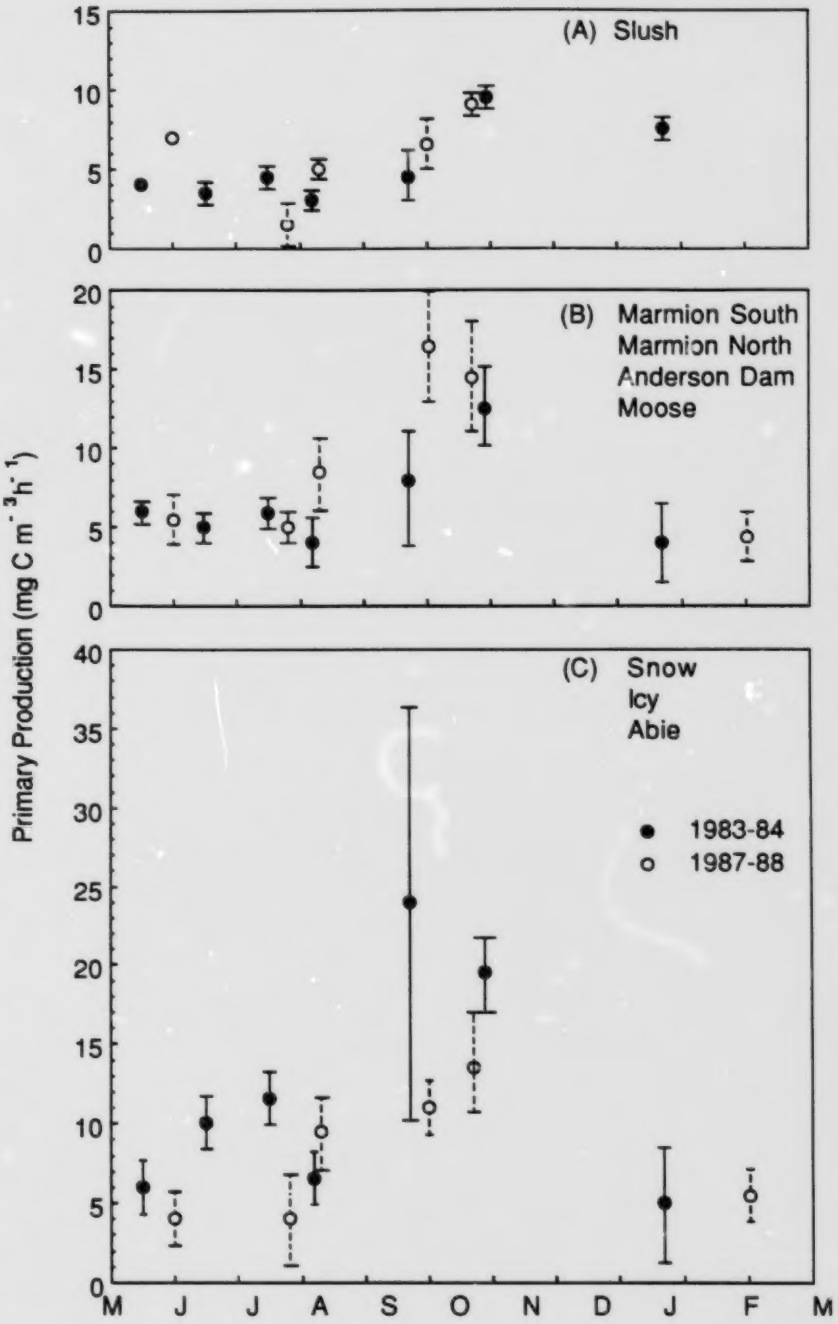


FIGURE 3.1.3-1

TEMPORAL PATTERNS IN PRIMARY PRODUCTION (MEAN ± 1 S.D.) FOR (A) SLUSH LAKE, (B) MARMION LAKE LOCATIONS AND (C) SNOW, ICY AND ABIE LAKES DURING PRE- (1983-84) AND POST-OPERATIONAL (1987-88) STUDY PERIOD

TABLE 3.1.3-1

Multiple Range Comparison of Mean Primary Production Values (Log Transformed; mg $C/m^3/h$) for Months sampled in 1983-84 and 1987-88

1983-84 (1-way ANOVA $f_{(6,140)} = 12.4$; $p < 0.005$)

January	August	May	June	July	September	October
0.546	0.641	0.725	0.781	0.861	1.00	1.16
**********	**********			**********		*******
	**********					
		**********				

1987-88 (1-way ANOVA $f_{(5,127)} = 45.3$; $p < 0.005$)

July	March	June	August	September	October
0.472	0.590	0.657	0.906	1.10	1.12
**********	**********		******	**********	

3.2 Phytoplankton

In 1987 phytoplankton samples were collected monthly from May to October from Snow, Icy, Abie, Slush, Marmion (Marmion South, Marmion North and Anderson Dam) and Moose Lakes. In addition 1988 March samples were taken at Snow, Icy and Marmion Lakes (Marmion south, Marmion north and Anderson Dam). The same locations included in this study, as well as Lower Seine and Marmion Central were sampled monthly from May though October in 1981, and in February of 1982. All the 1987 locations, with the exception of Moose Lake, were sampled from May to October in 1983, as well as in January of 1984. In 1982 samples were collected in May, August and October only. In this section the 1987 phytoplankton data are described and compared to data collected in 1981 and 1983 and to a lesser degree to 1982 data.

Of the lakes sampled, Snow, Icy, Abie, Marmion and Moose Lakes are part of the water cooling circuit while Slush Lake is considered a control lake. It was anticipated that the discharge of sewage, liquid waste and cooling water from the station might lead to changes in the distribution, species composition, abundance, and growth of fish within the cooling circuit (Greig et al 1984). The link in this hypothesis involving phytoplankton is that changes may occur to the phytoplankton as a result of increased biological oxygen demand (BOD), increased levels of total dissolved solids, total suspended solids and temperature, and decreased pH. These changes in turn would result in increased secondary production and hypolimnetic oxygen depletion which would result in changes in fish distribution, composition and abundance.

As the discharge current passes through the circuit lakes, there is considerable mixing with lake water below and adjacent to the current. This results in the mixing of the phytoplankton of the discharge current and the circuit lakes. However, the degree of mixing was not known and therefore the effect of flushing on the densities of the phytoplankton of the circuit lakes could not be discussed.

The species composition and mean biomass (mg/m^3) of phytoplankton collected from May through October are presented in Table 3.2-1. March data was not included in this table because not all locations were sampled in this month. Complete phytoplankton data are included in Appendix 2.

3.2.1 Species Composition

The Bacillariophyceae (diatoms) and Pyrrophyta (flagellates, including dinoflagellates and cryptomonads) were the most common phytoplankton in the study lakes in 1987. In terms of mean biomass, the diatoms were the most important group in Slush Lake and at all three Marmion Lake locations. The flagellates were the main group present in Snow, Icy and Moose Lakes, while the diatoms and flagellates were of equal importance in Abie Lake. The diatoms and flagellates were also the most common phytoplankton present in the study area in 1981 and 1983.

TABLE 3.2-1
SPECIES COMPOSITION AND ANNUAL MEAN BIOMASS (MG/M*M*M) OF PHYTOPLANKTON
COLLECTED MONTHLY IN THE ATIKOKAN GS STUDY AREA
FROM MAY TO OCTOBER 1987

Location	Snow Lake		Icy Lake		Abie Lake		Slush Lake		Marmion South		Marmion North		Anderson Dam		Moose Lake	
	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%	mg/m*m*m	%
Cyanophyta	26.2	3.23%	50.6	4.89%	89.6	6.37%	62.4	7.11%	104.9	5.35%	41.3	4.35%	72.8	10.05%	75.1	7.38%
Anabaena sp	15.5	1.91%	38.5	3.71%	71.1	5.05%	19.3	2.20%	73.9	3.77%	20.6	2.16%	42.9	5.92%	48.1	4.73%
Oscillatoria sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	2.8	0.32%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Aphanizomenon flos-aquae	8.0	0.99%	10.9	1.06%	14.0	1.00%	19.6	2.23%	25.7	1.31%	14.4	1.51%	28.2	3.89%	26.4	2.59%
Microcystis sp	2.7	0.33%	1.2	0.12%	4.5	0.32%	20.7	2.36%	5.3	0.27%	6.4	0.67%	1.7	0.24%	0.3	0.03%
Merismopedia sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.4	0.04%
Chlorophyta	7.8	0.96%	22.8	2.20%	16.5	1.17%	40.6	4.62%	27.8	1.42%	91.8	9.65%	15.5	2.15%	29.9	2.94%
Ankistrodesmus falcatus	0.1	0.02%	1.1	0.11%	0.6	0.04%	0.3	0.03%	0.8	0.04%	0.2	0.02%	1.2	0.16%	0.0	0.00%
Ankistrodesmus mirabilis	0.1	0.01%	0.1	0.00%	0.0	0.00%	0.2	0.02%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Cosmarium sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	11.0	1.25%	5.5	0.28%	0.6	0.06%	0.0	0.00%	0.0	0.00%
Elakatothrix gelatinosa	0.6	0.07%	0.4	0.04%	0.3	0.02%	0.3	0.04%	0.7	0.03%	1.0	0.11%	0.9	0.13%	0.9	0.09%
Oocystis sp	0.4	0.05%	10.4	1.01%	2.1	0.15%	16.7	1.90%	6.7	0.34%	9.4	0.99%	1.7	0.23%	4.6	0.45%
Scenedesmus bijuga	0.5	0.06%	1.2	0.12%	0.3	0.02%	0.7	0.08%	0.5	0.02%	0.4	0.04%	0.1	0.01%	0.3	0.03%
Closterium sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	11.5	0.59%	69.0	7.26%	0.0	0.00%	0.0	0.00%
Kirchneriella sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.3	0.03%	0.0	0.00%
Franceia sp	0.0	0.00%	0.8	0.08%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Pediastrum sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	5.3	0.52%
Mougeotia sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	5.9	0.57%
Crucigenia sp	0.6	0.07%	0.8	0.08%	0.5	0.03%	0.0	0.00%	0.5	0.02%	0.8	0.08%	0.5	0.07%	0.9	0.09%
Lagerheimia sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.2	0.01%	0.0	0.00%	0.6	0.09%	0.1	0.01%
Selenastrum sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	1.0	0.11%	0.0	0.00%	0.0	0.00%
Golenkinia sp	0.0	0.00%	0.0	0.00%	0.0	0.00%	4.3	0.49%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Tetraedron sp	5.5	0.68%	7.9	0.76%	12.7	0.90%	7.1	0.81%	1.6	0.08%	9.5	1.00%	10.3	1.42%	11.9	1.17%
Pyrrophyta	549.4	67.84%	536.9	51.86%	603.4	42.91%	268.3	30.57%	398.3	20.31%	233.3	24.54%	233.1	32.18%	697.3	68.50%
Peridinium sp	1.4	0.17%	27.7	2.67%	44.3	3.15%	55.3	6.31%	1.4	0.07%	15.2	1.60%	0.0	0.00%	44.3	4.35%
Ceratium hirundinella	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	58.3	2.98%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Cryptomonas sp	428.3	52.89%	354.9	34.28%	451.7	32.12%	140.8	16.05%	220.0	11.22%	140.8	14.81%	123.2	17.01%	528.0	51.87%
Rhodomonas minuta	119.7	14.78%	154.3	14.90%	107.4	7.64%	72.1	8.22%	118.6	6.05%	77.3	8.13%	109.9	15.17%	125.0	12.28%
Chrysophyta: Chrysophyceae	27.7	3.42%	42.9	4.14%	37.1	2.63%	46.1	5.25%	57.0	2.91%	47.3	4.97%	35.9	4.96%	21.7	2.13%
Dinobryon sp	27.7	3.42%	42.9	4.14%	37.1	2.63%	46.1	5.25%	57.0	2.91%	47.3	4.97%	35.9	4.96%	21.7	2.13%
Chrysophyta: Baccillariophyceae	198.7	24.54%	382.1	36.91%	659.8	46.91%	460.2	52.44%	1372.8	70.01%	537.1	56.49%	366.8	50.66%	194.0	19.05%
Cyclotella sp	0.0	0.00%	1.5	0.14%	3.4	0.24%	3.0	0.34%	3.4	0.17%	1.1	0.12%	0.0	0.00%	0.0	0.00%
Cymbella sp	0.0	0.00%	0.0	0.00%	0.8	0.06%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.8	0.08%
Diatoma sp	0.3	0.04%	0.6	0.06%	0.6	0.04%	0.0	0.00%	4.4	0.22%	0.3	0.03%	0.0	0.00%	0.0	0.00%
Fragilaria sp	3.3	0.40%	12.8	1.23%	7.4	0.52%	0.0	0.00%	77.5	3.95%	0.0	0.00%	1.5	0.21%	0.0	0.00%
Fragilaria crotonensis	0.9	0.12%	1.1	0.10%	15.6	1.11%	0.0	0.00%	2.5	0.13%	0.6	0.06%	4.0	0.55%	5.1	0.50%
Melosira sp	31.1	3.84%	0.0	0.00%	25.2	1.79%	0.0	0.00%	126.2	6.44%	15.5	1.63%	48.5	6.70%	1.9	0.19%
Melosira granulata	0.0	0.00%	5.3	0.51%	174.9	12.44%	0.0	0.00%	95.4	4.87%	243.8	25.64%	121.9	16.83%	13.3	1.30%
Navicula sp	0.0	0.00%	1.7	0.16%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Pennales	26.7	3.29%	35.0	3.38%	56.7	4.03%	45.0	5.13%	26.7	1.36%	20.0	2.10%	14.2	1.96%	15.0	1.47%
Rhizosolenia sp	45.0	5.56%	65.0	6.28%	90.0	6.40%	25.0	2.85%	42.5	2.17%	37.5	3.94%	12.5	1.73%	62.5	6.14%
Rhoicosphenia curvata	5.3	0.65%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Stephanodiscus sp	3.0	0.37%	2.1	0.20%	1.3	0.09%	2.3	0.27%	4.5	0.23%	0.9	0.10%	4.0	0.55%	2.0	0.19%
Stephanodiscus binderanus	20.0	2.47%	62.5	6.04%	102.5	7.29%	42.5	4.84%	742.5	37.87%	50.0	5.26%	17.5	2.42%	0.0	0.00%
Stephanodiscus niagarae	0.0	0.00%	69.1	6.68%	86.4	6.14%	0.0	0.00%	34.6	1.76%	86.4	9.09%	69.1	9.55%	0.0	0.00%
Tabellaria sp	1.7	0.21%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%	0.0	0.00%
Tabellaria fenestrata	16.7	2.06%	77.1	7.45%	20.8	1.48%	287.5	32.77%	139.6	7.12%	39.6	4.16%	40.0	5.52%	20.8	2.05%
Synedra sp	1.7	0.21%	4.2	0.40%	0.0	0.00%	44.2	5.03%	3.3	0.17%	0.0	0.00%	0.0	0.00%	0.8	0.08%
Total	809.7	100.00%	1035.3	100.00%	1406.3	100.00%	877.4	100.00%	1960.8	100.00%	950.8	100.00%	724.1	100.00%	1018.0	100.00%

The cyanophytes (blue-green algae) were not as prominent in Snow Lake as they had been in 1983 (Haymes 1985a). In that year the proliferation of blue-greens in Snow Lake was associated with sewage discharge and were responsible for the high primary production measured in Snow Lake in September of 1983 (see section 3.1.1).

The importance of the diatoms increased along the cooling circuit between Moose and Marmion Lakes while that of the flagellates decreased between Moose and Marmion Lakes. A similar trend occurred in 1981, but not in 1983.

The flagellate *Cryptomonas* sp was the most common phytoplankton in Snow, Icy, Abie and Moose Lakes. The diatom *Tabellaria fenestrata* was the most common taxon in Slush Lake, *Stephanodiscus binderanus* at Marmion South, and *Melosira granulata* at Marmion North. *Cryptomonas* sp and *Melosira granulata* were the main taxa present at Anderson Dam.

Other common and widespread (occurring at all locations) taxa included the blue-green algae *Anabaena* sp, *Aphanizomenon flos-aquae*, and *Microcystis*, and the chlorophytes (green algae) *Elekatothrix gelatinosa*, *Oocystis* sp, *Stephanodiscus binderanus* and *Tetraedron* sp. The flagellate *Rhodomonas minuta*, the chrysophyte (golden alga) *Dinobryon* sp, and the diatoms *Asterionella gracillima*, *Rhizosolenia* sp, *Stephanodiscus* sp, *Tabellaria fenestrata*, and a group of unidentified pennales were also among the more common and widespread taxa present in the study area. These taxa were also present at all locations in 1983. *Microcystis* sp, *F. crotonensis*, *T. fenestrata* and *Stephanodiscus* spp were not as widespread in 1981.

The number of phytoplankton taxa identified ranged from 24 in Slush Lake to 31 at Marmion South. In 1981, the species diversity was also lowest in Slush Lake but was highest in Snow Lake, and ranged from 26 to 42. In 1983 species diversity did not vary much among locations and ranged from 23 in Icy and at Marmion South to 26 in Slush. A larger number of taxa were identified in the 1981 samples than in the 1983 and 1987 samples. Although this could be indicative of a change in phytoplankton diversity, it is likely, at least in part, a result of infrequent sampling (monthly) in the three study years.

3.2.2 Seasonal Distribution

At most sampling locations the flagellates were the most important group present during the summer months (Figures 3.2.2-1 to 3.2.2-8). Exceptions were Slush Lake where diatoms dominated most of the year, and Marmion North where the golden algae dominated in June and the green algae in July. The diatoms dominated in the spring and/or fall at all locations except Snow and Moose Lakes, where the flagellates dominated on all sampling occasions. The spring and fall dominance of diatoms was probably related to spring and fall turnover (Haymes 1989b, in draft) which replenish the water column with nutrients allowing for the proliferation of the diatoms. In March, 1988, the flagellates dominated the algal biomass at Marmion South and Marmion North and the diatoms at Icy Lake. The flagellates and diatoms co-dominated at Snow Lake and the blue-greens dominated at Anderson Dam.

In the Experimental Lakes Area in northern Ontario, the mid-summer phytoplankton was dominated by the golden algae (Schindler and Holmgren 1971). The diatoms were only an important part of the phytoplankton biomass in some of the ELA Lakes studied by Schindler and Holmgren (1971), while the flagellates made up major portions. The similarity in the importance of the flagellates and the differences in the proportions of the diatom and chrysophyceae biomass in the ELA lakes and our study lakes were also noted in the 1981 and 1983 reports (Haymes 1983 and 1985a).

Total biomass was highest in September or October at all locations. Blue-green algal biomass peaked in August/September at all locations except Slush Lake where it peaked in October (Figures 3.2.2-1 to 3.2.2-8). The green algae peaked in May at all locations except Slush Lake where they peaked in October, and Marmion North and Moose Lake where they peaked in July and August, respectively. The flagellates peaked in September/October at all locations but Marmion South where they peaked in July. Maximum golden algae biomass occurred in June/July at all locations but Slush Lake, where it peaked in May. The diatoms peaked in May and September in Snow Lake and in September/October at the remaining locations.

Spring and fall maxima are common for diatoms in the temperate zone (Smith 1950). Spring peaks were probably missed at the locations other than Snow Lake due to infrequent sampling or because the spring maxima preceded our first sampling date. A similar observation was made on the primary production seasonal trend (see section 3.1.3). Seasonally, phytoplankton biomass and primary production were both highest either in September or October at all locations.

3.2.3 Spatial Distribution

Mean biomass ranged from 724 mg/m^3 at Anderson Dam to 1961 mg/m^3 at Marmion South (Table 3.2.3-1). Phytoplankton biomass was lowest at Anderson Dam from June through August and was highest at Marmion South in May and October. A bloom of *S. binderanus* at Marmion South in October resulted in the highest biomass estimate (6634 mg/m^3) obtained for any location during the 1987-1988 study period.

Mean phytoplankton biomass was lowest in Slush Lake in 1981 and at Anderson Dam in 1983. It was highest at Marmion South in 1981 and was higher in the first three lakes of the cooling circuit (Snow, Icy and Abie lakes) than at the remaining locations in 1983.

In 1987-1988, primary production was also highest at Marmion South. Primary production levels were lowest at Slush Lake followed by Snow Lake. With the exception of Anderson Dam, biomass was also lower at these two locations than at the remaining locations. In 1983-1984, the phytoplankton biomasses estimated for the study locations were related to their primary production and nutrient levels with highest levels found in Snow, Icy and Abie lakes and lower levels found in Marmion and Slush lakes.

Figure 3.2.2-1
PHYTOPLANKTON DENSITIES (MG/M3)
SNOW LAKE, 1987

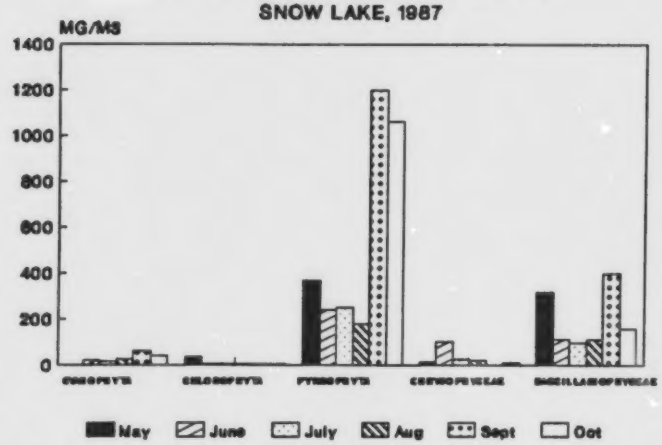


Figure 3.2.2-2
PHYTOPLANKTON DENSITIES (MG/M3)
ICY LAKE, 1987

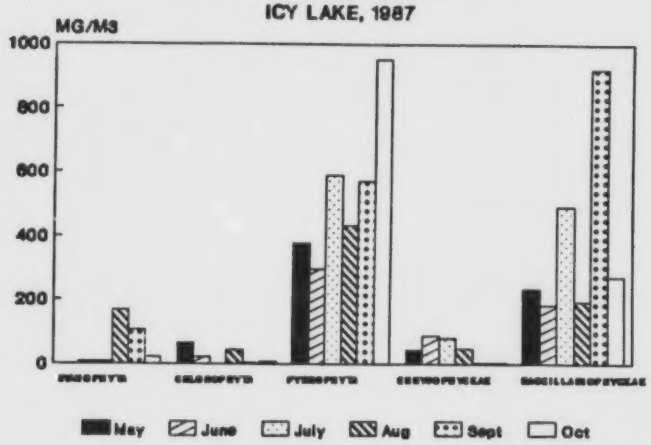


Figure 3.2.2-3
PHYTOPLANKTON DENSITIES (MG/M3)
ABIE LAKE, 1987

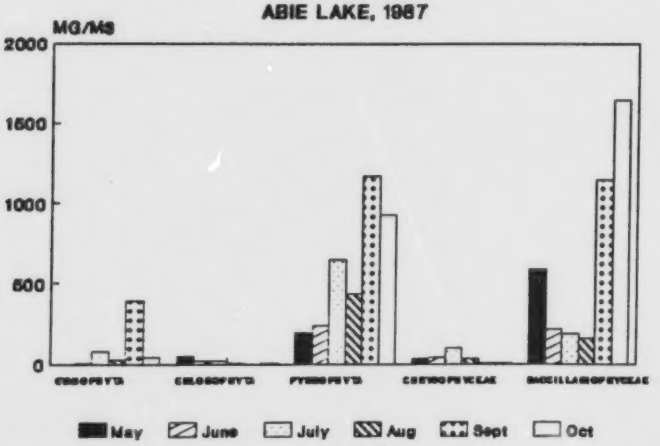


Figure 3.2.2-4
PHYTOPLANKTON DENSITIES (MG/M3)
SLUSH LAKE, 1987

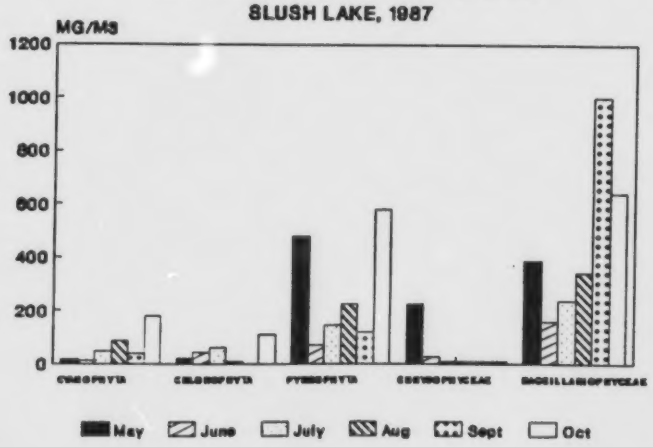


Figure 3.2.5
PHYTOPLANKTON DENSITIES (MG/M3)
MARMION SOUTH, 1987

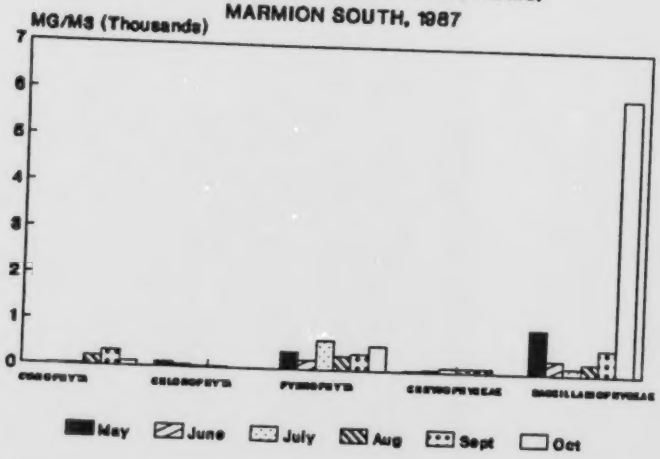


Figure 3.2.2-6
PHYTOPLANKTON DENSITIES (MG/M3)
MARMION NORTH, 1987

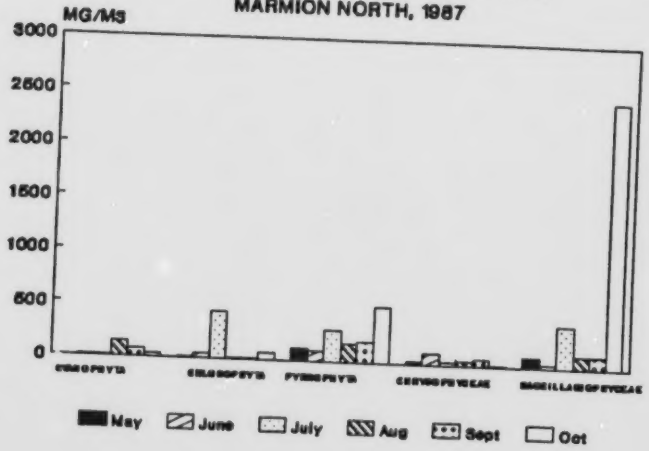


Figure 3.2.2-7
PHYTOPLANKTON DENSITIES (MG/M3)
ANDERSON DAM, 1987

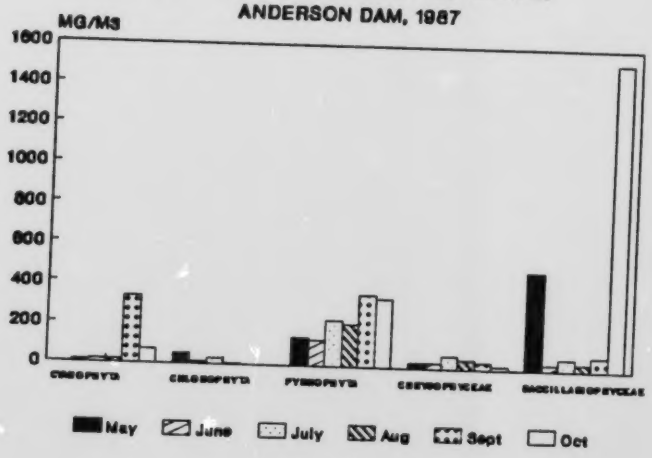


Figure 3.2.2-8
PHYTOPLANKTON DENSITIES (MG/M3)
MOOSE LAKE, 1987

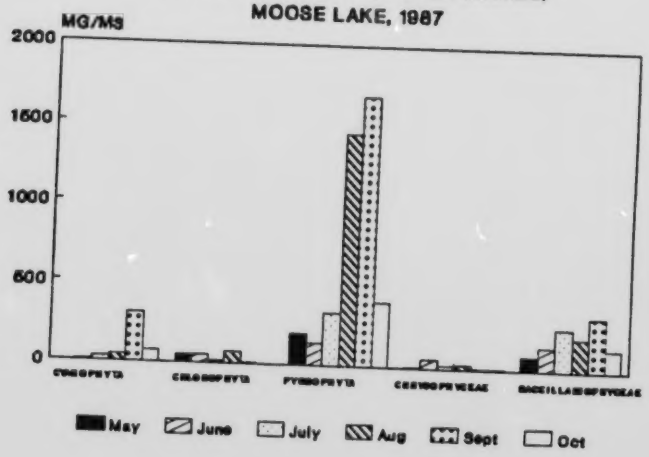


TABLE 3.2.3-1
MAY TO OCTOBER MEAN PHYTOPLANKTON DENSITIES (MG/M3)
1981, 1983 AND 1987, ATIKOKAN TGS

	1981	1983	1987
SNOW LAKE	370.5	1855.5	809.7
ICY LAKE	347.8	962.3	1035.3
ABIE LAKE	566.5	1430.5	1406.3
SLUSH LAKE	178.9	670.7	877.4
MARMION SOUTH	873.9	783.9	1960.8
MARMION NORTH	803.6	500.0	950.8
ANDERSON DAM	416.9	460.8	724.1
MOOSE	ND	ND	1018

ND=NO DATA

3.2.4 Comparison of 1981, 1982, 1983 and 1987 Data

Mean biomass estimates (May to October) were higher in 1987 than they had been in 1981 at all locations (Table 3.2.3-1). The 1987 densities were higher or comparable to 1983 estimates at all locations except Snow Lake where phytoplankton biomass was considerably higher in 1983 than in 1987.

When mean densities for May, August and October data only for 1981, 1982, 1983 and 1987 were compared, 1982 had lowest biomass estimates at Abie Lake, Slush Lake, Marmion South and Marmion North, while biomass at Snow Lake, Icy Lake and Anderson Dam were within the range obtained in the remaining years (Table 3.2.4-1).

3.2.5 Overview

The diatoms and flagellates were the most important phytoplankton in the study lakes in all study years. The prominence of the blue-green algae in Snow Lake associated with sewage discharge observed in 1983 (Haymes 1985a) was not observed in 1987.

Although the spatial distribution of algal biomass was quite different in 1987 than it was in 1983, there were some similarities between the 1987 and 1981 distributions. Generally, phytoplankton biomass appears to have increased while species diversity appears to have decreased since 1981. In addition, some of the more common phytoplankton taxa appear to be more widespread than they were in 1981. However, these apparent differences may be part of natural annual variation and/or an artifact of infrequent sampling.

3.3 Zooplankton

Zooplankton samples were collected monthly from May to October, 1987, from Snow, Icy, Abie, Slush, Marmion (Marmion South, Marmion North and Anderson Dam) and Moose lakes. In 1981, the same locations included in the 1987 study, as well as Lower Seine and Marmion Central were sampled monthly from early June through October (Slush Lake from late June through October). In 1983, all the 1987 locations except Moose Lake were sampled from May through October. In this section the 1987 data are compared to the 1981 and 1983 data. In 1982 samples were collected from Snow, Icy, Abie and Marmion (Marmion South, Marmion North and Anderson Dam) lakes in May, August and October only. Therefore comparisons of the 1982 data with those collected in the remaining years are limited in this section.

The hypothesis related to the zooplankton studies is the same as that described for the phytoplankton. Chemical changes and changes in algae and macrophytes as a result of the discharge of sewage, liquid waste and cooling water from the station could result in increased secondary production and hypolimnetic oxygen depletion. This in turn would result in changes in fish distribution, composition and abundance (Greig et al 1984).

TABLE 3.2.4-1

COMPARISON OF PHYTOPLANKTON MEAN BIOMASS (MG/M3) FOR MAY/EARLY JUNE, AUGUST AND OCTOBER, 1981, 1982, 1983 AND 1987, ATIKOKAN TGS STUDY AREA

	1981	1982	1983	1987
SNOW LAKE	361	793	2535	780
ICY LAKE	306	461	916	950
ABIE LAKE	648	471	2027	1386
SLUSH LAKE	NO MAY DATA	415	639	1100
MARMION SOUTH	1052	457	962	2976
MARMION NORTH	938	288	NO OCT DATA	1272
ANDERSON DAM	310	540	527	986

As in the case of the phytoplankton, the zooplankton densities in the circuit lakes are affected by the flushing effect of the discharge current. Again, since the degree of mixing of the discharge current and the circuit lakes is not known, the zooplankton densities presented could not be discussed in terms of flushing effect.

3.3.1 Rotifers

The species composition and mean densities (No/m^3) of the rotifers collected from May through October are presented in Table 3.3.1-1. Complete rotifer data are included in Appendix 3.

3.3.1.1 Species Composition

The species composition of the rotifers was quite similar at all locations. In terms of mean densities *Keratella cochlearis*, *Kellicottia longispina*, *Polyarthra* spp, and *Asplanchna* spp were the most abundant rotifers. *K. cochlearis* was the most abundant species present at all locations except Icy and Anderson Dam where *K. longispina* was most abundant. *Polyarthra* spp was more abundant than *Asplanchna* spp at all locations except Anderson Dam and Moose Lake.

Other more common and widespread (occurring at all locations) taxa included *Trichocerca cylindrica*, *Trichocerca multicrinis*, *Trichocerca longiseta*, *Synchaeta* spp, *Filinia longiseta*, *Conochilus unicornis and Gastropus* spp.

K. cochlearis, *K. longispina* and *Polyarthra* spp were also the three most abundant taxa present in the study lakes in 1981 and 1983 (Haymes 1983 and 1985a). These taxa have been described as dominant forms in oligotrophic lakes while taxa belonging to *Asplanchna*, *Gastropus* and *Conochilus* are among common forms in oligotrophic lakes (Ruttner-Kolisko 1974).

Pejler (1965) also found *K. cochlearis*, *K. longispina*, *Polyarthra*, *Synchaeta (oblonga, tremula* and *pectinata)*, *C. unicornis* and *Asplanchna priodonta* to be common in oligotrophic lakes.

Acres (1976) identified *K. cochlearis*, *Asplanchna* and *Polyarthra* as the most common rotifers in the Atikokan study area in 1975.

In discussing species diversity, taxa identified to genus were counted as discreet taxa. Thus in the cases where several species belonging to a genus were identified and unidentified forms of this genus are lumped under genus spp, the collective group under genus spp was counted as a single taxa.

A total of 31 rotifer taxa were identified in the study area with the number of taxa at the various locations ranging from 16 at Marmion North to 21 at Snow Lake. Species diversity appears to vary considerably among years. In 1981 a total of 42 taxa were identified with species diversity ranging from 16 at Slush Lake to 30 at Icy. In 1983, 24 taxa were identified and the number of taxa found at each location ranged from 16 at Abie Lake to 20 at Snow Lake. Again, as in the case of the phytoplankton the differences in species.

TABLE 3.3.1-1
SPECIES COMPOSITION AND MEAN DENSITIES (NO/M*M*M) OF ROTIFERS
COLLECTED MONTHLY IN THE ATIKOKAN GS STUDY AREA
FROM MAY TO OCTOBER 1987

Location	Snow Lake		Icy Lake		Abie Lake		Slush Lake		Marmion South		Marmion North		Anderson Dam		Moose Lake	
	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%
ROTIFERA																
Brachionus spp	0	0.0%	9	0.0%	823	0.5%	0	0.0%	234	0.3%	4	0.0%	0	0.0%	0	0.0%
Brachionus clayciflorus	3	0.0%	0	0.0%	0	0.0%	0	0.0%	187	0.2%	25	0.1%	0	0.0%	0	0.0%
Keratella cochlearis	23577	31.8%	44827	39.1%	101020	60.9%	5791	27.9%	47364	53.9%	11683	44.0%	64826	58.1%	43363	55.7%
Keratella hiemalis	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Keratella quadrata	3538	4.8%	2660	2.3%	1489	0.9%	197	0.9%	0	0.0%	349	1.3%	1178	1.1%	662	0.9%
Notholca sp	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	2	0.0%
Notholca acuminata	0	0.0%	269	0.2%	329	0.2%	101	0.5%	234	0.3%	99	0.4%	34	0.0%	35	0.0%
Kellicottia longispina	26649	36.0%	27706	24.2%	28591	17.2%	9867	47.5%	26688	30.4%	7638	28.8%	28136	25.2%	21075	27.1%
Lepadella spp	101	0.1%	0	0.0%	494	0.3%	0	0.0%	94	0.1%	0	0.0%	0	0.0%	0	0.0%
Lecane spp	135	0.2%	0	0.0%	0	0.0%	3	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lecane luna	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	9	0.0%	0	0.0%
Lecane lunaris	11	0.0%	0	0.0%	4	0.0%	0	0.0%	0	0.0%	0	0.0%	6	0.0%	56	0.1%
Trichocerca spp	67	0.1%	135	0.1%	0	0.0%	0	0.0%	234	0.3%	0	0.0%	6	0.0%	0	0.0%
Trichocerca cylindrica	202	0.3%	174	0.2%	258	0.2%	331	1.6%	234	0.3%	16	0.1%	208	0.2%	362	0.5%
Trichocerca multicrinis	48	0.1%	441	0.4%	2097	1.3%	6	0.0%	1047	1.2%	123	0.5%	104	0.1%	257	0.3%
Trichocerca similis	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	18	0.0%
Trichocerca porcellus	9	0.0%	11	0.0%	0	0.0%	31	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Trichocerca longiseta	388	0.5%	1488	1.3%	303	0.2%	264	1.3%	154	0.2%	36	0.1%	23	0.0%	8	0.0%
Euchlanis dilatata	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	202	0.3%
Asplanchna spp	7659	10.3%	5619	4.9%	14764	8.9%	612	2.9%	3144	3.6%	841	3.2%	2015	1.8%	1004	1.3%
Polyarthra spp	6712	9.1%	13634	11.9%	8876	5.3%	2053	9.9%	3820	4.3%	3695	13.9%	12342	11.1%	9713	12.5%
Synchaeta spp	832	1.1%	941	0.8%	1033	0.6%	208	1.0%	308	0.4%	423	1.6%	301	0.3%	42	0.1%
Ploesoma spp	9	0.0%	6	0.0%	415	0.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ploesoma triacanthum	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	67	0.1%	0	0.0%
Filinia longiseta	1125	1.5%	13178	11.5%	1009	0.6%	79	0.4%	2008	2.3%	649	2.4%	623	0.6%	18	0.0%
Conochilus unicornis	236	0.3%	76	0.1%	93	0.1%	300	1.4%	154	0.2%	28	0.1%	180	0.2%	43	0.1%
Gastropus spp	2445	3.3%	2002	1.7%	2447	1.5%	697	3.4%	1524	1.7%	781	2.9%	1089	1.0%	651	0.8%
Trochosphaera	6	0.0%	581	0.5%	1055	0.6%	0	0.0%	4	0.0%	0	0.0%	0	0.0%	0	0.0%
Collotheca sp	0	0.0%	0	0.0%	0	0.0%	23	0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Collotheca pellagica	0	0.0%	0	0.0%	0	0.0%	0	0.0%	94	0.1%	0	0.0%	150	0.1%	0	0.0%
Ascomorpha sp	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Unknown rotifer	360	0.5%	831	0.7%	897	0.5%	208	1.0%	347	0.4%	165	0.6%	374	0.3%	300	0.4%
Total	74109	100.0%	114587	100.0%	165996	100.0%	20771	100.0%	87872	100.0%	26554	100.0%	111668	100.0%	77810	100.0%

diversity is at least in part related to infrequent sampling. In addition, the level of identification may have varied somewhat between years with more species only identified to genus in some years.

3.3.1.2 Seasonal Distribution

K. cochlearis was the most common rotifer present in all months at the Marmion Lake locations and in Moose Lake (Figures 3.3.1-1 to 3.3.1-8). At the remaining locations, it was the most abundant rotifer present over most of the study period. The exception to the dominance of *K. cochlearis* in Snow Lake was the dominance of *K. longispina* in May and June and *Polyarthra* spp in August. In Icy and Slush Lakes, the exception was *K. longispina* dominance in May, and in Abie Lake, *K. cochlearis* co-dominated with *K. longispina* in June.

The rotifers occurred in substantially higher numbers in May-June than in the remaining months. Maximum densities occurred in May at all locations except Snow where it occurred in June. *K. cochlearis* peaked in May or June at all locations except Icy Lake where it peaked in July. *K. longispina*, *Asplanchna* spp and *Polyarthra* spp peaked in May/June with the former two taxa only found in very low numbers from July through October.

In 1981 when sampling was not initiated until early-June, the four main rotifers in the study area had high early summer densities indicative of spring population peaks, followed by low summer densities and subsequent fall peaks. In 1983, the seasonalities of these four taxa were somewhat more variable among locations, although May/June and fall peaks were common.

Acres (1976) reported June peaks for *K. cochlearis*, *Asplanchna* and *Polyarthra* at most of their sampling locations in the Atikokan study area in 1975.

At most locations species diversity was highest in June/July and lowest in October. In 1981 species diversity was highest in the summer at all locations and in 1983 diversity in the study lakes was highest in either late summer or early fall.

3.3.1.3 Spatial Distribution

The mean densities of the rotifers ranged from 165,996/m^3 at Abie Lake to 20,771/m^3 at Slush Lake (Table 3.3.1-2). Rotifer densities were higher at Abie Lake, Icy Lake, and Anderson Dam than at the remaining locations, and lower at Marmion North and Slush Lake. This spatial distribution was similar to that of 1981. In 1983 Snow, Icy and Abie lakes had higher densities than Slush Lake and the Marmion Lake locations.

The 1983 spatial distribution was consistent with that of the nutrient levels, phytoplankton biomass, primary production and crustacean zooplankton densities. No such consistency was obvious in 1987 although Icy and Abie Lakes were among the locations with higher phytoplankton biomass and Slush Lake was among those with lower phytoplankton biomass.

Figure 3.3.1-1
ROTIFER DENSITIES (NO/M3)
SNOW LAKE, 1987

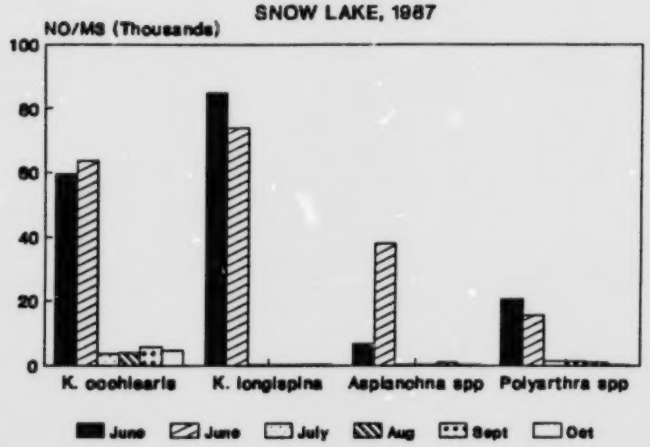


Figure 3.3.1-2
ROTIFER DENSITIES (NO/M3)
ICY LAKE, 1987

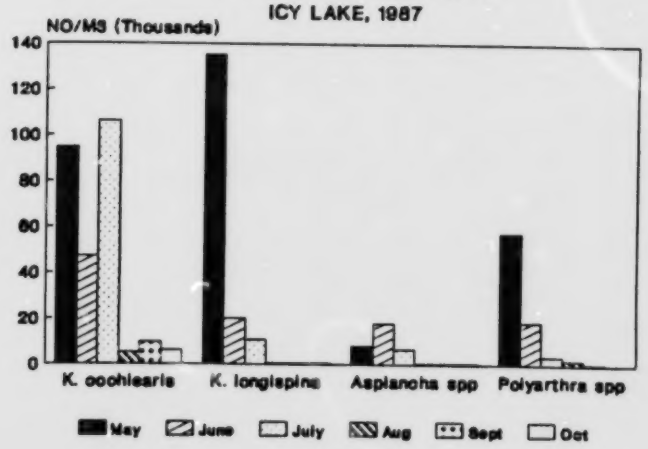


Figure 3.3.1-3
ROTIFER DENSITIES (NO/M3)
ABIE LAKE, 1987

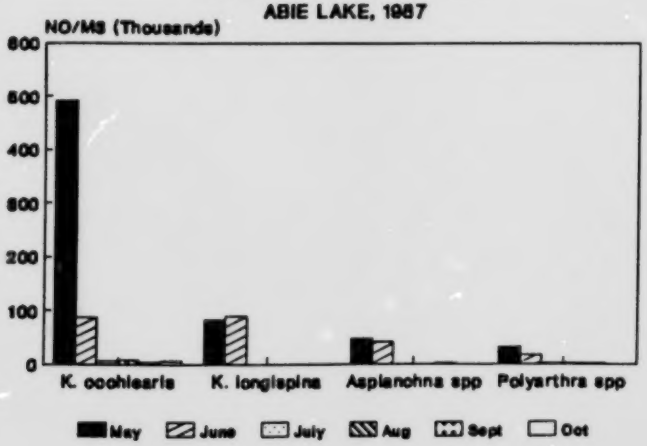


Figure 3.3.1-4
ROTIFER DENSITIES (NO/M3)
SLUSH LAKE, 1987

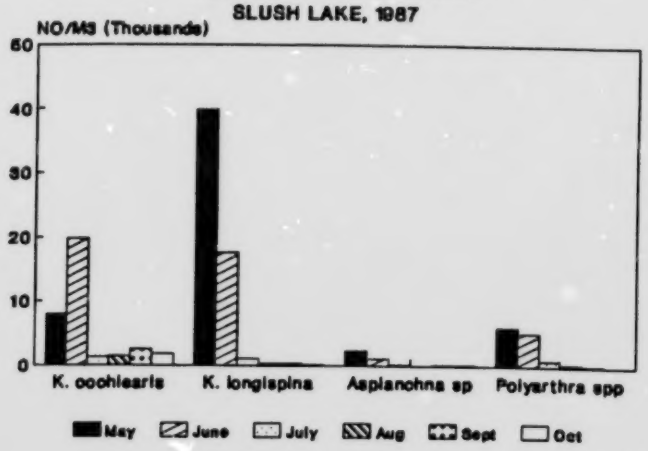


Figure 3.3.1-5
ROTIFER DENSITIES (NO/M3)
MARMION SOUTH, 1987

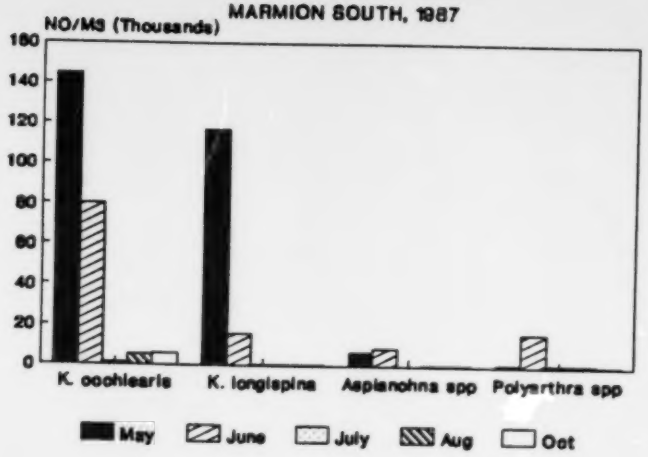


Figure 3.3.1-6
ROTIFER DENSITIES (NO/M3)

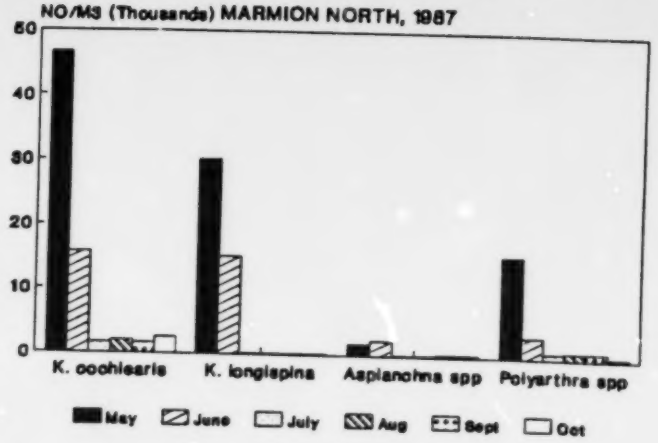


Figure 3.3.1.7
ROTIFER DENSITIES (NO/M3)
ANDERSON DAM, 1987

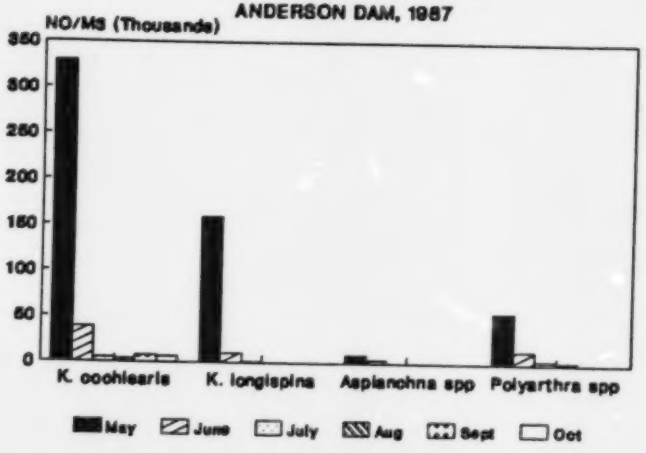


Figure 3.3.1-8
ROTIFER DENSITIES (NO/M3)
MOOSE LAKE, 1987

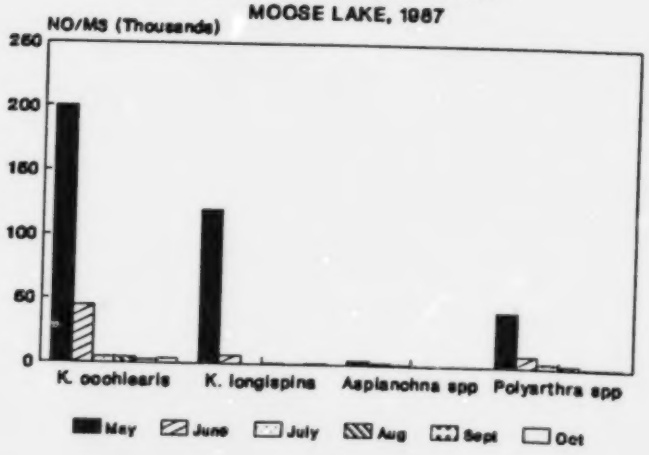


TABLE 3.3.1-2
MAY TO OCTOBER MEAN DENSITIES OF ROTIFERS (NO/M3)
1981, 1983, AND 1987, ATIKOKAN TGS

	1981	1983	1987
SNOW LAKE	57069	272177	74109
ICY LAKE	79399	283547	114587
ABIE LAKE	111948	121441	165996
SLUSH LAKE	6288	65313	20771
MARMION SOUTH	56988	57228	87872
MARMION NORTH	32193	58641	26554
ANDERSON DAM	77654	98436	111668
MOOSE LAKE	33415	ND	77810

ND=NO DATA

3.3.1.4 Comparison of 1981, 1982, 1983 and 1987 Data

With the exception of Marmion North, lowest mean densities (May to October) of rotifers were recorded in 1981 (Table 3.3.1-2). The lower mean densities obtained in 1981 may in part be due to the later date on which sampling was initiated in that year. At Marmion North lowest densities were found in 1987.

At Snow, Icy and Slush Lakes, and Marmion North highest densities were estimated in 1983 while at Abie Lake, Marmion South and Anderson Dam rotifer densities were highest in 1987. Comparison of the 1983 and 1987 densities suggests that the densities of the rotifers has not increased since the implementation of the cooling circuit. The hypothesis concerning zooplankton in the study area, was that chemical changes and changes in the algae and macrophytes as a result of the discharge from the station could result in increased secondary production.

Comparison of May, August and October data only, for 1981, 1982, 1983 and 1987 (Table 3.3.1-3) indicated that rotifer densities were lowest in 1982 at most of the sampling locations. The spatial distribution of the rotifers was quite similar to that of 1983 with higher densities found in Snow, Icy and Abie Lakes than in Marmion and Slush Lakes.

3.3.2 Crustacean Zooplankton

The species composition and mean densities (No/m^3) of the crustacean zooplankton collected monthly from May to October are presented in Table 3.3.2-1. Complete data are presented in Appendix 3.

3.3.2.1 Species Composition

At most locations, the calanoid and cyclopoid copepods made up similar portions of the crustacean zooplankton numbers while the cladocerans were less abundant. The exception was Abie Lake where the mean density of the cladocerans was higher than those of the calanoid or cyclopoid copepods.

Most of the cladocerans present in the study area were widespread, occurring at all eight sampling locations. *Daphnia retrocurva*, *Bosmina longirostris* and *D. longiremis* were the main cladocerans present in the study area. In addition to these three species the more common cladocerans included *Diaphanosoma leuchtenbergianum* and *Holopedium gibberum*.

The relative abundance as well as mean densities of *Bosmina longirostris* were considerably lower than they had been in 1983. *Daphnia galeata mendotae*, among the more prevalent cladocerans in the study lakes in 1981 and 1983, was absent from Marmion South and only occurred in low numbers at the remaining locations.

The densities presented for individual copepod species represent the number of adults (copepodite VI). In discussing the copepod densities it was assumed that most of the nauplii (larvae) and copepodites (juveniles) belonged to the same species as the most abundant adults present. *Diaptomus oregonensis* was

TABLE 3.3.1-3

COMPARISON OF ROTIFER DENSITIES (NO/M3) FOR MAY/EARLY JUNE, AUGUST AND OCTOBER, 1981, 1982, 1983 AND 1987, ATIKOKAN TGS STUDY AREA

	1981	1982	1983	1987
SNOW LAKE	84132	72616	306258	67474
ICY LAKE	136253	69810	220493	132129
ABIE LAKE	152268	75825	116857	237460
SLUSH LAKE	NO MAY DATA	28839	80366	21727
MARMION SOUTH	96188	31677	54010	100285
MARMION NORTH	52247	40597	41385	35038
ANDERSON DAM	124907	59574	96124	192704

TABLE 3.3.2-1
SPECIES COMPOSITION AND MEAN DENSITIES (NO/M*M*M) OF CRUSTACEAN ZOOPLANKTON
COLLECTED MONTHLY IN THE ATIKOKAN GS STUDY AREA
FROM MAY TO OCTOBER 1987

Location	Snow Lake		Icy Lake		Abie Lake		Slush Lake		Marmion South		Marmion North		Anderson Dam		Moose Lake	
	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%	No/m*m*m	%
CLADOCERA																
Diaphanosoma leuchtenbergianum	65	0.2%	1302	2.7%	511	1.5%	77	0.5%	333	1.1%	469	3.7%	290	0.7%	334	1.1%
Holopedium gibberum	312	1.0%	654	1.4%	415	1.2%	317	2.0%	1347	4.3%	661	5.1%	1077	2.6%	220	0.7%
Daphnia longiremis	1021	3.4%	2402	5.1%	992	2.9%	171	1.1%	479	1.5%	131	1.0%	572	1.4%	407	1.3%
Daphnia retrocurva	444	1.5%	4304	9.1%	3363	9.7%	562	3.6%	2903	9.3%	1132	8.8%	4057	9.9%	1299	4.1%
Ceriodaphnia spp	88	0.3%	797	1.7%	135	0.4%	337	2.2%	352	1.1%	70	0.5%	60	0.1%	71	0.2%
Daphnia spp	623	2.1%	1350	2.8%	2559	7.4%	326	2.1%	943	3.0%	222	1.7%	988	2.4%	1075	3.4%
Daphnia ambigua	135	0.5%	269	0.6%	0	0.0%	0	0.0%	47	0.2%	74	0.6%	135	0.3%	0	0.0%
Chydorus spp	28	<0.1%	37	<0.1%	21	<0.1	119	0.8%	38	0.1%	6	0.0%	11	<0.1%	12	<0.1%
Bosmina longirostris	1347	4.5%	1308	2.8%	6106	17.6%	659	4.3%	1934	6.2%	760	5.9%	4446	10.8%	3916	12.5%
Eubosmina corigoni	438	1.5%	337	0.7%	247	0.7%	236	1.5%	0	0.0%	296	2.3%	202	0.5%	943	3.0%
Alona spp	0	0.0%	67	0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Daphnia galeata mendotae	303	1.0%	67	0.1%	11	<0.1	118	0.8%	0	0.0%	125	1.0%	174	0.4%	18	0.1%
Chydorus sphaericus	0	0.0%	0	0.0%	0	0.0%	82	0.5%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
COPEPODA																
CALANOIDA																
Diaptomus oregonensis	1524	5.1%	2102	4.4%	2608	7.5%	1738	11.2%	1749	5.6%	1443	11.2%	3906	9.5%	2648	8.4%
Diaptomus minutus	14	<0.1%	67	0.1%	14	<0.1%	76	0.5%	0	0.0%	8	<0.1%	110	0.3%	109	0.3%
Diaptomus ashlandi	3	<0.1%	9	<0.1%	4	<0.1%	9	<0.1%	12	<0.1%	36	0.3%	183	0.4%	19	<0.1%
Calanoid nauplii	10285	34.4%	12546	26.5%	7709	22.2%	4631	29.9%	7316	23.5%	1983	15.4%	8249	20.1%	6164	19.6%
Calanoid copepodites	1107	3.7%	2599	5.5%	860	2.5%	1131	7.3%	1957	6.3%	662	5.2%	2630	6.4%	2233	7.1%
Diaptomus siciloides	6	<0.1%	9	<0.1%	0	0.0%	6	<0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Limnocalanus macrurus	3	<0.1%	6	<0.1%	7	<0.1%	0	0.0%	0	0.0%	49	0.4%	14	<0.1%	0	0.0%
Eurytemora affinis	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	<0.1%
Epischura lacustris	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	5	<0.1%
CYCLOPOIDA																
Cyclops bicuspidatus thomasi	1732	5.8%	3965	8.4%	2955	8.5%	717	4.6%	3876	12.4%	1671	13.0%	4523	11.0%	4518	14.4%
Cyclops vernalis	122	0.4%	234	0.5%	399	1.1%	82	0.5%	97	0.3%	140	1.09%	351	0.9%	144	0.5%
Mesocyclops edax	707	2.4%	0	0.0%	0	0.0%	9	<0.1%	6	<0.1%	0	0.00%	11	<0.1%	2	0.0%
Cylopoid nauplii	8022	26.8%	10182	21.5%	4057	11.7%	3187	20.6%	5214	16.7%	1871	14.55%	4871	11.9%	4837	15.4%
Cyclopoid copepodites	1584	5.3%	2798	5.9%	1757	5.1%	899	5.8%	2540	8.2%	1030	8.01%	4213	10.3%	2450	7.8%
Tropocyclops prasinus	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	18	0.14%	17	<0.1%	9	<0.1%
Total	29913	100.0%	47409	100.0%	34730	100.0%	15486	100.0%	31144	100.0%	12858	100.00%	41089	100.0%	31432	100.0%

the most abundant calanoid copepod present and *Cyclops bicuspidatus thomasi* (*Diacyclops bicuspidatus*) the most abundant cyclopoid copepod present in 1981, 1983 and 1987.

Acres (1976) found *B. longirostris*, *Diaphanosoma brachyurum*, *D. galeata mendotae*, *Chydorus* and *Ceriodaphnia* to be the most common cladocerans in the study area in 1975. *C. bicuspidatus thomasi* was found to be the main cyclopoid copepod and *Diaptomus minutus* and *D. sicilis* to be the most common calanoid copepods present in the study area in 1975.

Schindler and Novén (1971) found *C. bicuspidatus thomasi* and *D. minutus* to be the numerically dominant crustacean zooplankton in the 45 ELA lakes they studied.

In discussing cladoceran species diversity, Daphnia spp was not counted as a distinct taxa since it contained young daphnids that were not speciated. The number of crustacean zooplankton taxa identified over the study period ranged from 13 at Marmion South to 20 at Snow Lake. In 1981 the number of taxa found ranged from 12 at Slush Lake to 16 at Marmion South, and in 1983 it ranged from 10 at Abie Lake to 12 at Marmion North.

In both 1983 and 1987 species diversity was typically found to be higher in the summer months. In 1981 it was higher in the summer or fall at most locations.

3.3.2.2 Seasonal Distribution

B. longirostris was the dominant cladoceran at most locations in May, September and October. The exceptions were the *Eubosmina* sp dominance at Snow Lake and Marmion North in May, and the dominance of *D. leuchtenbergianum* in Icy Lake in May. In June, *D. retrocurva* was the most abundant species at all locations but Snow Lake. In July, *D. leuchtenbergianum* was dominant or co-dominant at all locations but Snow and Moose lakes where *B. longirostris* was the most abundant cladoceran. *D. leuchtenbergianum* dominance continued into August at Abie Lake, Marmion South and Marmion North. *B. longirostris* was the most abundant species at all the remaining sites with the exception of Slush Lake where *Chydorus sphaericus* was more abundant.

D. oregonensis was the most abundant calanoid copepod species present throughout the sampling season at most locations. Exceptions were the dominance of *Diaptomus ashlandi* at Marmion North and Anderson Dam in August and October, respectively, and the dominance of *D. minutis* at Abie and Moose Lakes in August.

At most locations, *C. bicuspidatus thomasi* was the most abundant cyclopoid copepod species present from May through August and *C. vernalis* in September/October.

At all locations except Icy Lake, the densities of the cladocerans, calanoid copepods and cyclopoid copepods were substantially higher in May and June than in the remaining months (Figures 3.3.2-1 to 3.3.2-8). At Icy Lake, crustacean zooplankton numbers remained high from May through August. In 1981, the

Figure 3.3.2-1
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
SNOW LAKE, 1987

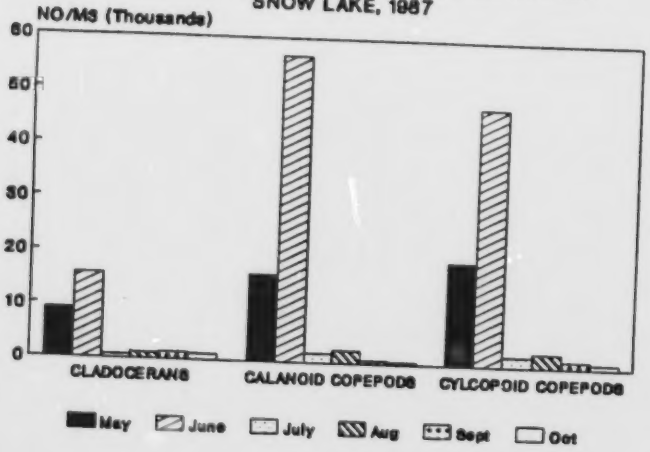


Figure 3.3.2-2
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
ICY LAKE, 1987

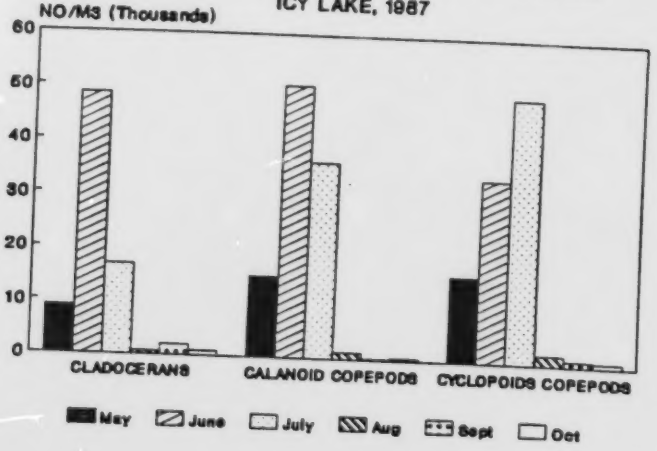


Figure 3.3.2-3
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
ABIE LAKE, 1987

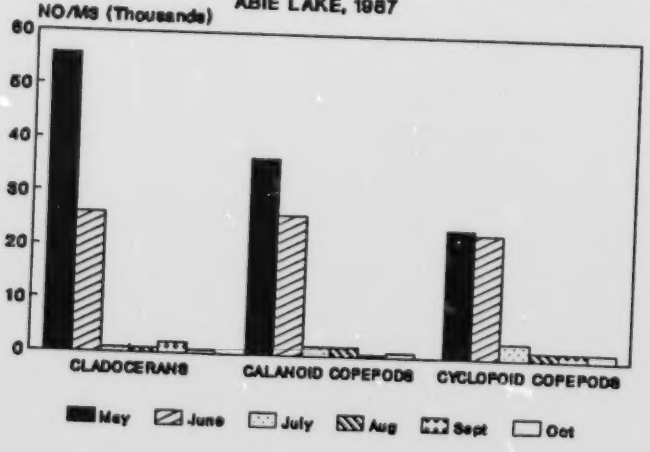


Figure 3.3.2-4
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
SLUSH LAKE, 1987

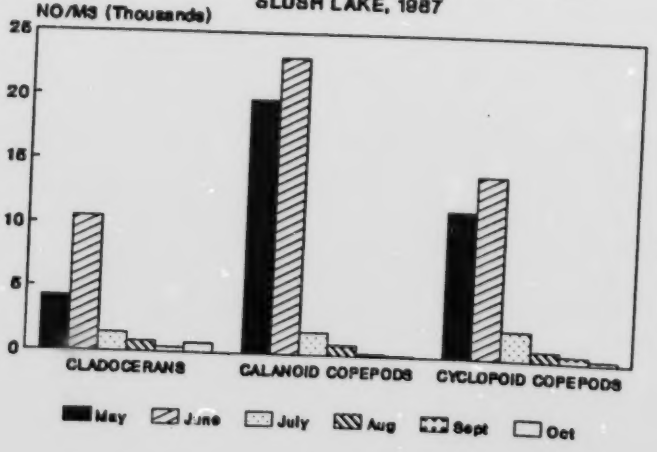


Figure 3.3.2-5
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
MARMION SOUTH, 1987

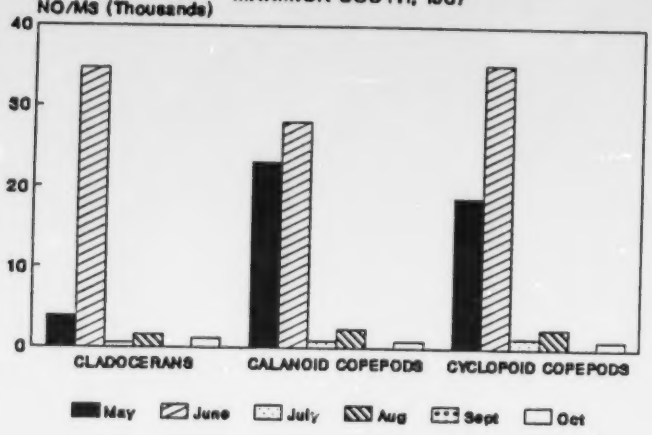


Figure 3.3.2-6
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
MARMION NORTH, 1987

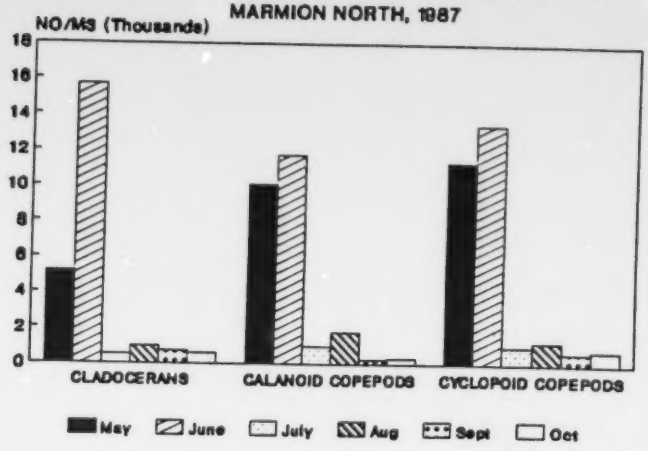


Figure 3.3.2-7
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
ANDERSON DAM, 1987

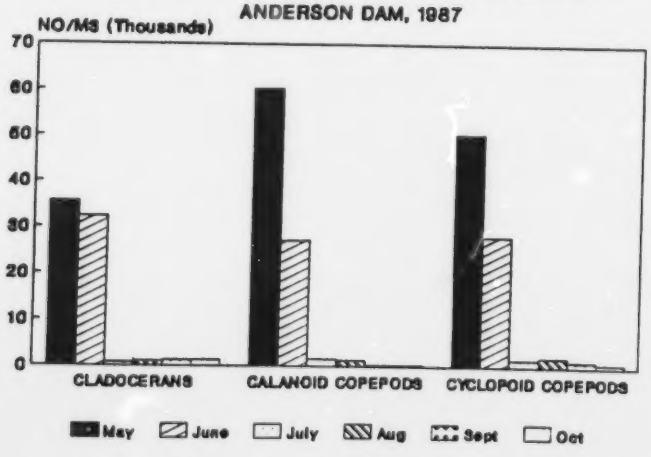
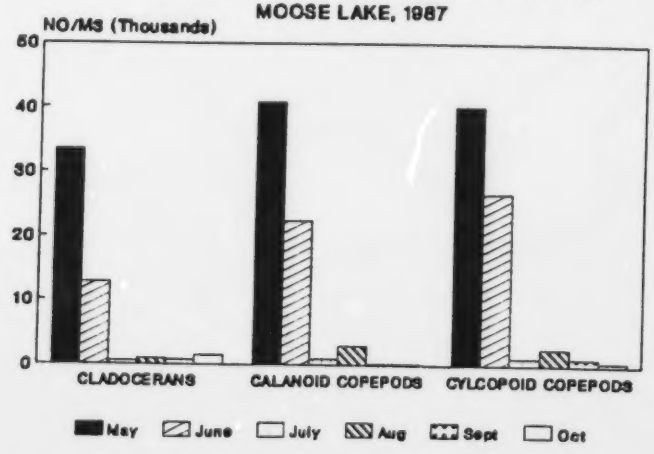


Figure 3.3.2-8
CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
MOOSE LAKE, 1987



cladocerans peaked in May or in the fall at most locations. The occurrence of peak densities of calanoid copepods in that year was quite variable between locations while the cylopoid copepods generally had early summer and/or fall peaks. The 1983 seasonalities of the calanoid and cyclopoid copepods were more similar to those of 1987 with May/June peaks at most locations while the cladocerans peaked in August/September.

3.3.2.3 Spatial Distribution

The spatial distribution of the crustacean zooplankton was quite similar to that of the rotifers with higher densities found in Icy Lake, Anderson Dam and Abie Lake than in the remaining lakes, and lower numbers found in Slush Lake and at Marmion North (Table 3.3.2-2). In 1981 and 1983 Snow and Abie Lakes were also among the three locations with the highest numbers of crustacean zooplankton while Slush Lake had the lowest crustacean zooplankton densities.

3.3.2.4 Comparison of 1981, 1982, 1983 and 1987 Data

Mean densities (May to October) of the crustacean zooplankton were higher in 1983 than in 1981 or 1987 in all study lakes (Table 3.3.2-2). Densities were lower in 1981 than in the remaining two study years at all locations except Marmion North where lowest densities were found in 1987.

Comparison of mean densities of crustacean zooplankton for May, August and October data only for 1981, 1982, 1983 and 1987 indicated that the 1982 densities were within the range obtained in the remaining years for all locations but Anderson Dam (Table 3.3.2-3). The mean density estimated for this location in 1982 was lower than it was in the remaining study years.

3.3.3 Overview

The most common rotifers and crustacean zooplankton present in the study area were similar in 1981, 1983 and 1987. However, the relative abundance of *B. longirostris* had declined between 1983 and 1987 and was more similar to that recorded in 1981 while that of *D. galeata mendotae* had declined since 1981. The cyclopoid copepods had been the most abundant group of crustacean zooplankton in 1981 and 1983; however, in 1987 its relative abundance was diminished while that of the calanoid copepods had increased.

Comparison of May to October data collected in 1981, 1983 and 1987 suggest that the densities of the rotifers and crustacean zooplankton have not increased since the implementation of the cooling water circuit. The hypothesis concerned with zooplankton in the study area was that changes in algae and macrophytes as a result of the discharge from the station would result in increased secondary production.

The rotifers were most abundant in 1983 at most locations while the crustacean zooplankton were most abundant in 1983 at all locations. The zooplankton densities were lowest in 1981 at most sampling locations. This is, atleast in part, related to the late initial sampling date of early June which precluded sampling of the spring population peaks observed in 1983 and 1987.

TABLE 3.3.2-2

MAY TO OCTOBER MEAN CRUSTACEAN ZOOPLANKTON DENSITIES (NO/M3)
1981, 1983 AND 1987, ATIKOKAN TGS

	1981	1983	1987
SNOW LAKE	21635	83746	29913
ICY LAKE	19995	75852	47409
ABIE LAKE	31669	78168	34730
SLUSH LAKE	10166	26579	15486
MARMION SOUTH	21394	39620	31144
MARMION NORTH	13078	43132	12858
ANDERSON DAM	36149	68010	41089
MOOSE LAKE	10245	ND	31432

ND=NO DATA

TABLE 3.3.2-3

COMPARISON OF CRUSTACEAN ZOOPLANKTON (NO/M3) FOR MAY/EARLY JUNE, AUGUST AND OCTOBER, 1981, 1982, 1983 AND 1987, ATIKOKAN TGS STUDY AREA

	1981	1982	1983	1987
SNOW LAKE	24230	45293	59575	17472
ICY LAKE	34569	19766	66353	15270
ABIE LAKE	26675	32710	68860	41178
SLUSH LAKE	NO MAY DATA	17382	20592	12945
MARMION SOUTH	33462	26067	36507	18328
MARMION NORTH	20533	26625	34791	10736
ANDERSON DAM	55902	47071	63275	50818

The spatial distribution of the rotifers in 1987 was more similar to their 1981 spatial distribution than that of 1983. The 1987 spatial distribution of the crustacean zooplankton were comparable to their 1981 and 1983 distributions at the extremes of the ranges. Snow and Abie Lakes were among the locations with the highest densities and Slush Lake among the locations with the lowest densities in all three years.

Comparison of 1981, 1982 and 1983 preoperational and 1987 postoperational zooplankton data suggests that the discharge of sewage, liquid waste and cooling water from the station has not resulted in any obvious changes in the zooplankton of the study area that can be distinguished from year-to-year variation.

3.4 Macrophytes

The concerns over macrophytes in the Atikokan TGS cooling circuit lakes during the postoperational phase are the potential effects of water level stabilization due to the construction of dams, weirs and channels as well as the discharge of cooling water (Greig et al 1984). The stabilization of water levels may result in an increase in macrophyte distribution while the thermal effluent may affect the distribution as well as the density of macrophytes.

Macrophyte surveys were conducted in the Atikokan study area in 1981, 1982, 1983, 1985, 1986 (Haymes 1983, 1984 and 1985a, and Haymes and Kwik 1987 and 1988). With the exception of 1981, identical surveys were conducted in each of these study years. Transects in selected areas within the cooling circuit were established in Snow Lake (northwest bay), Icy Lake (west and east bays), Abie Lake (east basin) and Marmion Lake (near Abie Lake and near Anderson Dam) in 1982. Slush Lake was included as a control lake. In 1981 a general survey of the macrophytes at all locations except the area in Marmion Lake near Abie Lake was conducted. The results of the 1987 and 1988 surveys are described in this section and are compared to those obtained in previous surveys.

3.4.1 Species Composition

A list of species and the lakes in which they were found is presented in Table 3.4.1-1. The species lists for Icy, Abie and Marmion lakes are based on surveys conducted along set transects in areas selected for special study. The species lists for Snow and Slush lakes are based on whole lake surveys. The scientific and common names of the macrophytes are listed in Appendix 4. Lists of species found along transects in the special study areas in 1987 and 1988 are presented in Appendices 5 and 6, respectively.

A total of 38 macrophytes and one charophyte (macrophytic alga) were identified in both the 1987 and 1988 surveys. As in previous years, the three growth forms of aquatic plants (emergents, floating-leafed and submergents) considered typical of plant communities were present in the study lakes. The growth forms of the species as observed during the surveys are presented in Table 3.4.1-1. Twenty-nine of the macrophytes were submergents and floating-leafed, and 9 were emergents.

TABLE 3.4.1-1

MACROPHYTE SPECIES OBSERVED IN THE ATIKOKAN STUDY LAKES FROM 1981 THROUGH 1986

	Snow						Icy						Abie						Slush						Marmion					
	81	82	83	85	86	87	88	81	82	83	85	86	87	88	81	82	83	85	86	87	88	81	82	83	85	86	87	88	81	82	83	85	86	87	88
Macrophytes:																																			
Beckmannia syzigachne (Steud.) Fern, e																													X						
Brasenia schreberi Gmel., e													X	X	X	X	X	X	X	X	X				X	X	X								
Calamagrostis canadensis (Michaux) Beauv., e																													X						
Callitriche hermaphroditica L., s			X						X	X	X	X	X	X															X	X	X	X	X	X	X
C. heterophylla Pursh., s																													X	X			X		
Ceratophyllum demersum L., s			X																										X	X	X	X	X	X	X
Chamaedaphne calyculata (L.) Moench , e																											X	X					X	X	X
Dulichium arundinaceum (L.) Britton, e															X				X								X	X							
Eleocharis acicularis (L.) R. & S., s			X						X						X	X													X	X		X	X	X	X
E. paulustris (L.) R. & S., e															X														X		X				
Elodea canadensis (Nichx.) Rich., s	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X					X	X	X	X	X	X	X	X	X
Equisetum sp., e	X								X				X	X	X														X						
Eriocaulon septangulare With., s	X																																		
Glyceria borealis (Nash) Batch., F			X								X				X	X											X	X		X	X	X	X	X	X
G. canadensis (Nichx.) Trin, s																		X																	
G. grandis S. Watson, e																							X	X					X	X		X			
Hippurus vulgaris L., e																							X	X								X			
Isoetes spp., s				X														X																	
Iris sp					X	X	X				X																X	X					X		
Juncus effusus L., e															X																	X	X	X	X
Lemna spp., f			X																				X												
Lobelia dortmanna L., e	X																																		
Megalodonta beckii (Torr.), s					X	X	X				X	X	X	X				X	X	X	X													X	X
Nimmulus ringens L., e															X														X						
Myriophyllum alterniflorum D.C., s	X								X		X						X	X	X	X	X								X	X	X	X	X	X	X
M. exalbescens Fern., s	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X
Najas flexilis (Willd.) R. & S., s	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Nuphar sp., f	X							X			X				X	X	X	X		X	X	X	X	X	X		X	X							
Nymphaea odorata Ait., f	X							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Nymphaea tetragona Georgi., f																		X																	
Polygonum natans Eat., f											X	X			X	X	X	X	X	X	X				X	X	X	X	X		X				
Potamogeton alpinus Balbis, s,f				X																									X						
P. amplifolius Tuckerm., s	X		X	X	X	X	X				X		X		X					X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
P. crispus, s																				X															
P. epihydrus Raf., s,f	X	X	X	X	X	X	X		X		X	X	X	X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. foliosus Raf., s		X	X	X	X	X	X			X	X			X															X	X					
P. friesii Rupr., s							X		X		X	X	X	X			X		X	X	X														
P. gramineus L., s.f.	X			X	X				X						X	X	X	X	X	X	X								X		X	X	X	X	X
P. natans L, s,f									X	X	X	X	X					X	X		X								X	X		X		X	X
P. obtusifolius Mert & Koch., s		X	X	X						X																									
P. pectinatus L., s									X																				X						
P. praelongus Wulfen., s								X			X		X	X															X		X	X	X	X	X
P. pusillus L., s	X		X	X	X	X	X	X			X		X	X				X	X	X	X								X	X		X	X	X	X
P. richardsonii (Benn.) Rydb., s	X		X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X			X					X	X	X	X	X	X	X
P. robbinsii Oakes., s	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
P. spirillus Tuckerm., s,f					X	X		X					X	X													X	X	X	X	X	X	X	X	X
P. strictifolius Benn., s					X	X		X	X		X		X	X				X																	
P. vaseyi Robbins, s,f																					X														
P. zosteriformis Fern., s				X	X	X	X			X	X		X	X	X														X	X	X	X	X	X	X
Ranunculus tricophyllus Chaix., s	X	X	X	X					X	X	X	X	X	X	X		X												X	X	X	X	X	X	X
Rorippa islandica (Oeder.)Borbas, s															X														X						
Sagittaria spp., e,s	X		X		X				X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X
Scirpus spp., e,s			X	X	X	X	X				X	X	X	X						X	X		X	X		X	X	X	X	X		X	X	X	X
Sium suave Walt., e															X	X		X											X	X		X			
Sparganium fluctuans (Morong.) Robinson, f	X										X	X	X	X				X														X			
Typha spp., e		X	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X
Utricularia vulgaris L., s	X								X		X				X	X	X	X	X	X	X								X	X					
Vallisneria americana Michx., s	X		X							X	X	X	X	X	X	X	X		X	X	X				X					X					
Charophytes:																																			
Chara sp., s	X	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X								X			X	X	X	X
unidentified Charophytes, s			X																										X		X				
Total Number of Taxa	22	10	24	18	20	19	17	17	18	19	30	20	27	26	26	18	20	25	19	22	24	11	12	14	11	12	18	18	35	32	22	30	28	28	28

The most common and widespread emergents (occurring in at least four of the five study lakes) were *Typha* spp (cattail), *Scirpus* spp (bulrush) and *Sagittaria spp* (arrowhead), and the most common and widespread floating-leafed form was *Nymphaea odorata* (water lily). The more common and widespread submergent macrophytes included *Elodea canadensis* (waterweed), *Megalodonta beckii* (water marigold), *Myriophyllum exalbescens* (water milfoil), *Najas flexilis* (bushy pondweed), *Potamogeton amplifolius* (large-leaf pondweed), *P. epihydrus* (leafy pondweed), *P. richardsonii* (clasping-leafed pondweed), and *P. robbinsii* (Robbin's weed). Of these macrophytes, *P. amplifolius* and *P. pusillus*, although present in the study area, were not as widespread in previous years.

Of the common and widespread submergents, *Elodea canadensis*, *Myriophyllum exalbescens*, *Najas flexilis*, *Potamogeton amplifolius*, *Potamogeton richardsonii* and *Potamogeton robbinsii* are considered to be typical of hard water (Hutchinson 1975). *Potamogeton epihydrus* is considered to be eurytopic, occurring at a wide range of alkalinities.

In both years lowest number of taxa were found in Snow and Slush Lakes and the highest number was found in Marmion Lake (Table 3.4.1-1). Seventeen taxa were identified at Snow Lake in 1987 and in Slush Lake in 1987 and 1988, and 16 taxa were observed in Snow Lake in 1988. Twenty-seven taxa were observed in Marmion Lake in both years. Slush Lake had the lowest number of taxa in all previous study years except 1982 when the diversity in Snow Lake declined following the 1981-1982 water drawdown. Marmion Lake had the highest number of taxa in all years except 1983 when the raising of the water level in Snow Lake resulted in increased diversity in that lake. The low number of species in Slush Lake is probably related to a lack of suitable habitat for submergents due to the nature of its steep shoreline.

With the exception of Slush Lake, the number of taxa identified in the various study lakes were within the range observed between 1981 and 1986. In Slush Lake, higher numbers were recorded in 1987 and 1988 then in previous years. Species not recorded for Slush Lake in previous years included *Potamogeton spirillus*, *Chamaedaphne calyculata*, *Iris sp*, *and Glyceria borealis*. Differences in species numbers recorded for individual lakes among years may in part be due to differences in sampling efficiency since species of low abundance can easily be missed in a qualitative survey.

3.4.2 Distribution and Abundance of Macrophytes

As in past years, the spatial distribution of the macrophytes conformed with the typical temperate zonation pattern of emergent, floating-leafed to submergent macrophyte dominance with increasing depth and distance from shore. This pattern was most pronounced in the west bay of Icy Lake and the east basin of Abie Lake. In the northwestern bay of Snow Lake the floating-leafed forms were scarce while in the east bay of Icy Lake, Slush Lake and the two study locations in Marmion Lake there was a patchy distribution of one or more of these communities.

Snow Lake

Since 1982, Snow Lake has differed from the other study locations in the scarcity of floating-leafed forms and the prominence of *E. canadensis* (Figure 3.4.2-1 and 3.4.2-2).

Loss of habitat due to the 1981-1982 water drawdown as well as increased currents from the discharge may have prevented the recolonization of *N. odorata*. However, the distribution of floating-leafed forms other than *N. odorata* has increased in 1987 and 1988 over that observed between 1982 and 1985. The main floating-leafed form present in 1987 and 1988 was *P. epihydrus*.

As in previous years, *Typha* spp and *Scirpus* spp were the most common emergents along the shores of Snow Lake.

The distribution and cover of submergent macrophytes has increased steadily in Snow Lake since 1982. In that year, the bays along the shore of Snow Lake were either sparsely colonized or devoid of submergents. By 1988, there was a discontinuous band of growth around the lake up to the 3 m depth. *N. flexilis* was the more common form up to the 1 m depth followed by *E. canadensis* at the deeper depths.

The increase in abundance of *E. canadensis* started in 1982 following the 1981-1982 water drawdown. In 1985, in the northwest bay of Snow Lake, where the station cooling water discharges into Snow Lake, *E. canadensis* was more abundant than it had been during the preoperational study (1981 - 1983). Although its prominence had declined somewhat in 1986, in 1987 and 1988 *E. canadensis* was the most common submergent in the bay (Figures 3.4.2-3 to 3.4.2-5).

E. canadensis was identified as a potentially problematic species in the preoperational summary report (Haymes 1986). This species is well adapted to spread by vegetative means since its stems are easily broken and readily form adventitious roots (St. John 1965). In addition, it lacks a dormancy mechanism which permits it to grow in the winter. Thus ice-free conditions created by the thermal plume would give it a competitive advantage. The proliferation of *E. canadensis* in Lake Wabamun was attributed to the absence of winter ice cover in areas heated by the thermal plume of Wabamun GS (Haag and Gorham 1977).

Other species present in the northwest bay of Snow Lake that are known to be photosynthetically active in winter are *P. amplifolius* and *P. robbinsii* (Boylen and Sheldon 1976). *P. amplifolius* was prominent along transect 4, near the discharge, in 1988, while *P. robbinsii* has been on the increase in the northwest bay of Snow Lake since 1986.

The 1988 species diversity along transects 3 and 4, just north of the discharge, were higher than they had been in previous years. In addition, the macrophytes in this area were covered with heavy growth of epiphytic algae.

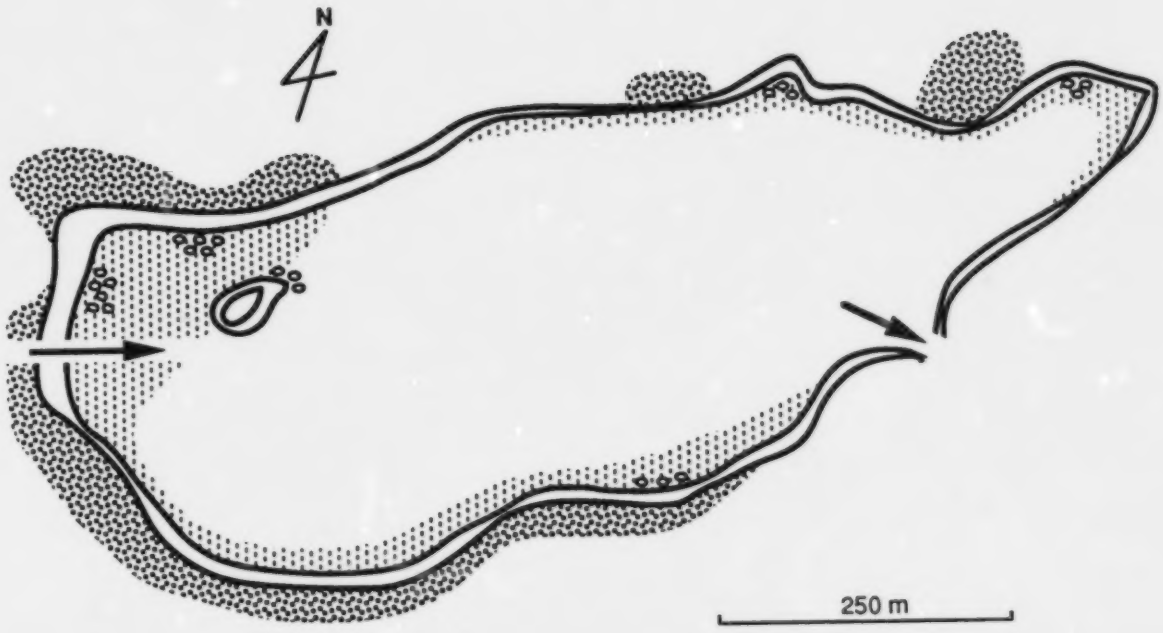


FIGURE 3.4.2-1
DISTRIBUTION OF MACROPHYTES IN SNOW LAKE IN 1987

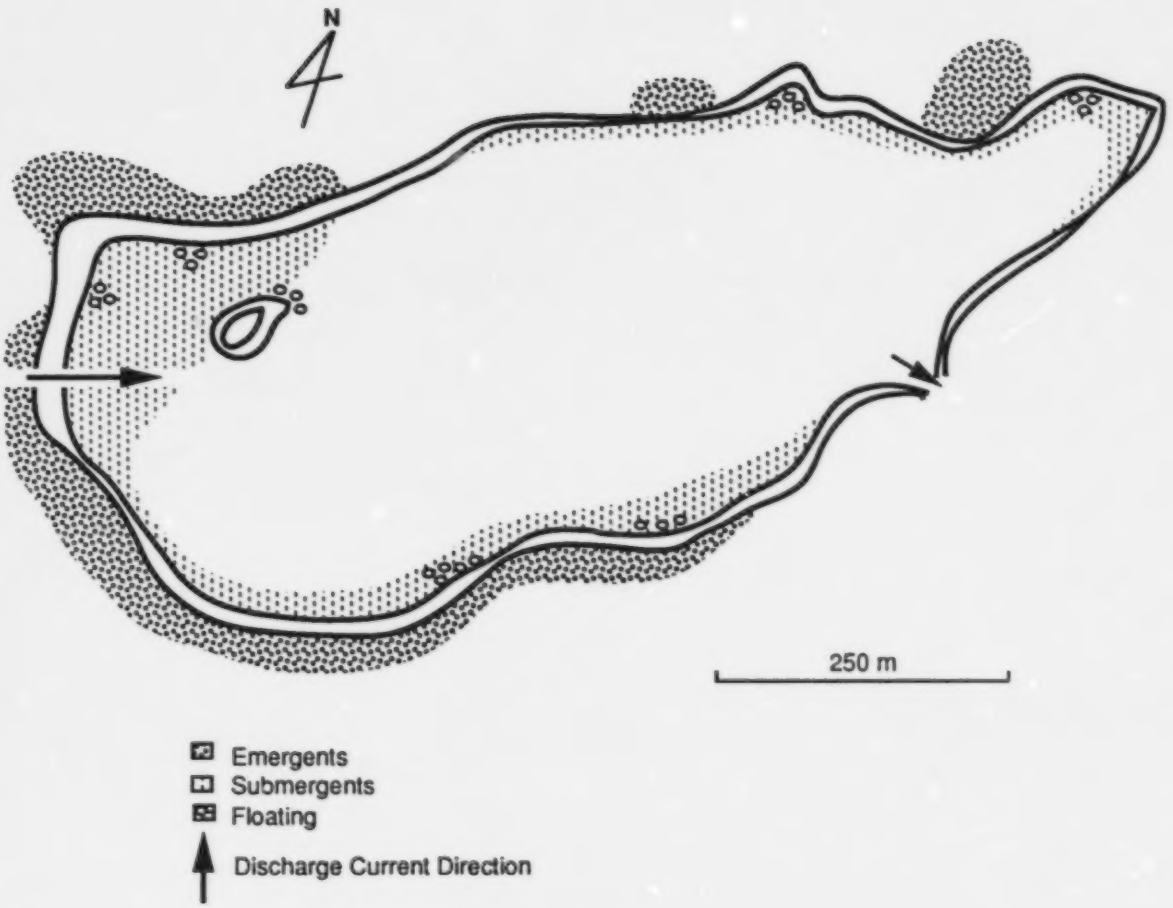


FIGURE 3.4.2-2
DISTRIBUTION OF MACROPHYTES IN SNOW LAKE IN 1988

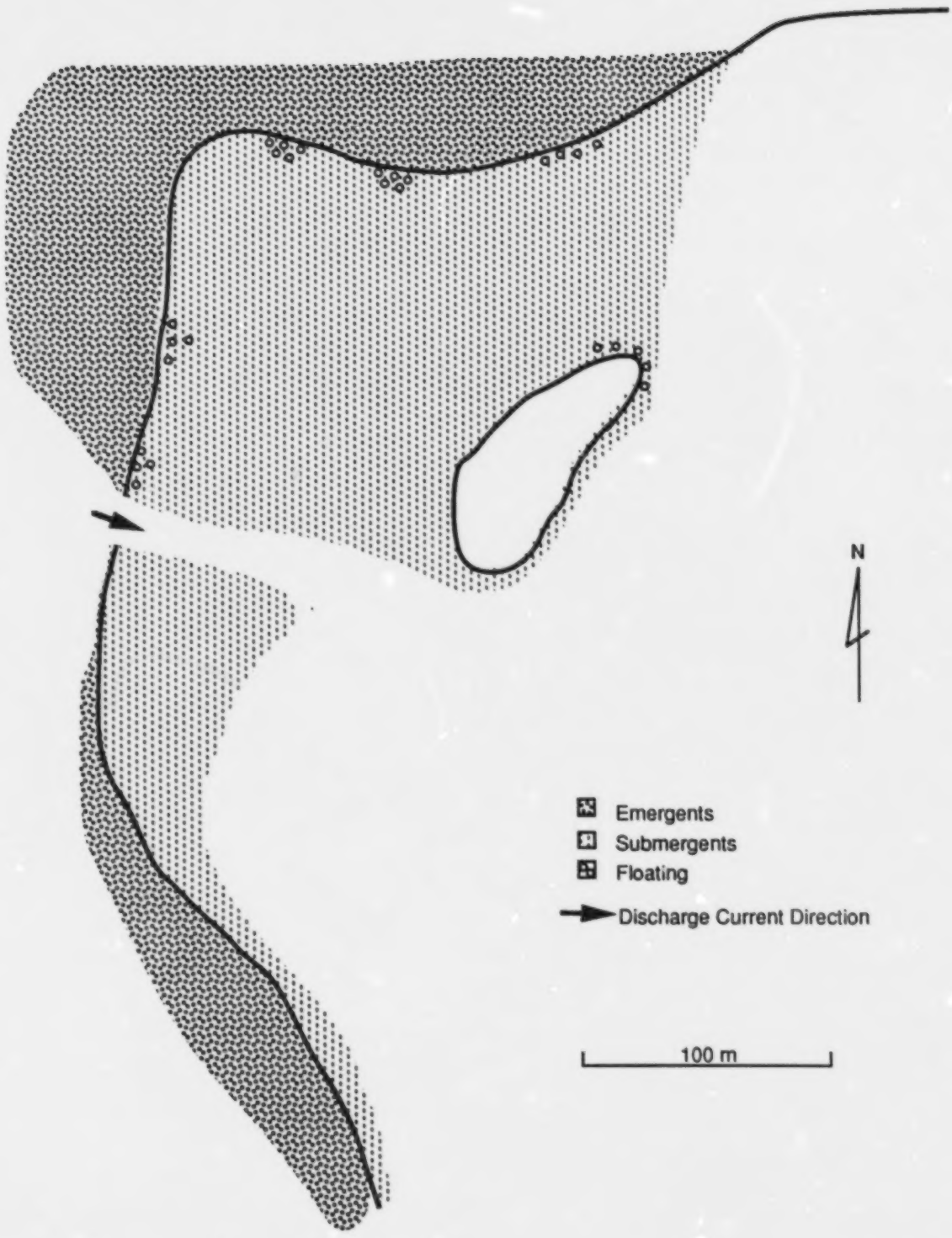


FIGURE 3.4.2-3
DISTRIBUTION OF MACROPHYTES ALONG WEST SHORE OF SNOW LAKE IN 1987 AND 1988

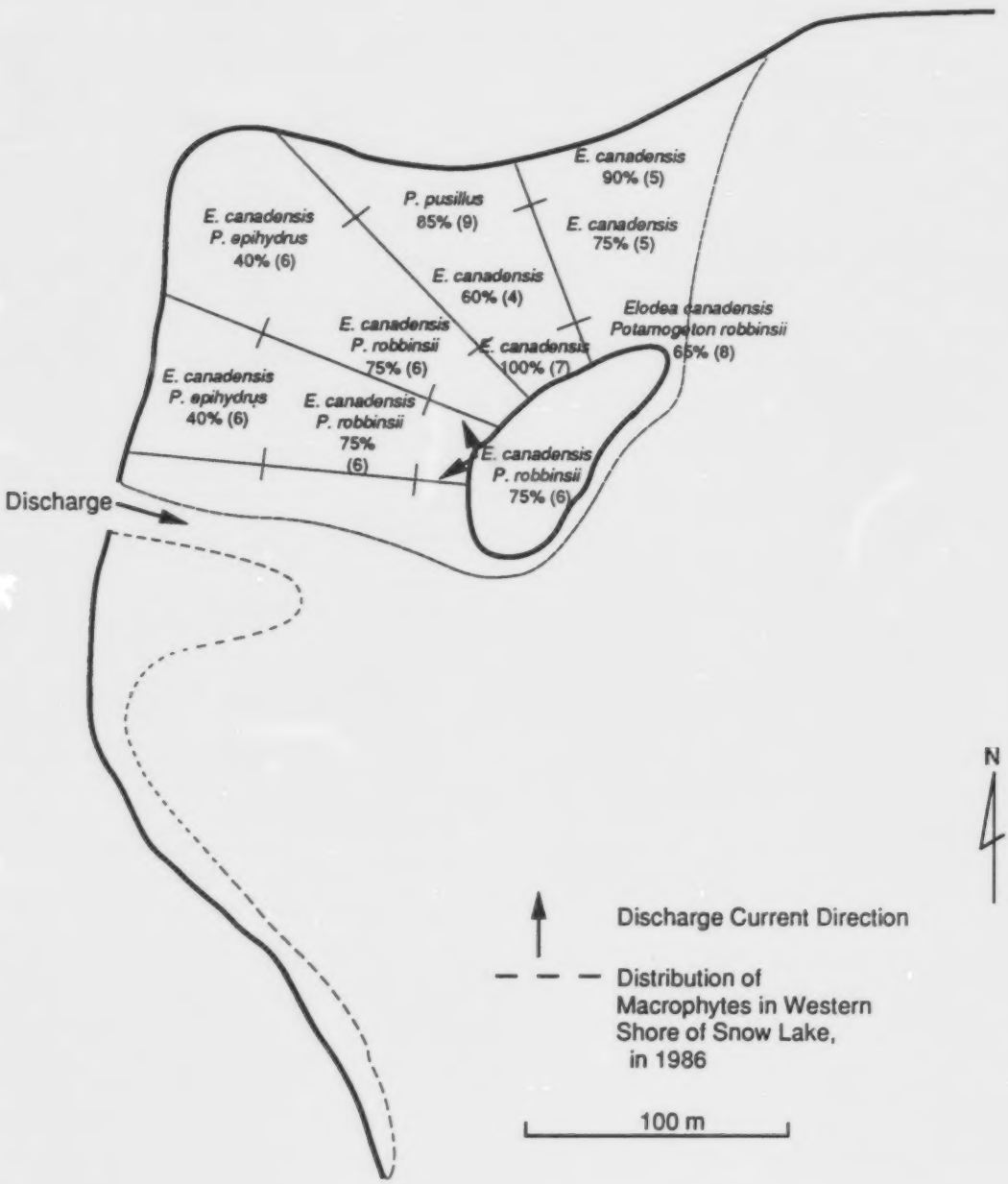


FIGURE 3.4.2-4

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) ALONG WESTERN SHORE OF SNOW LAKE, 1987

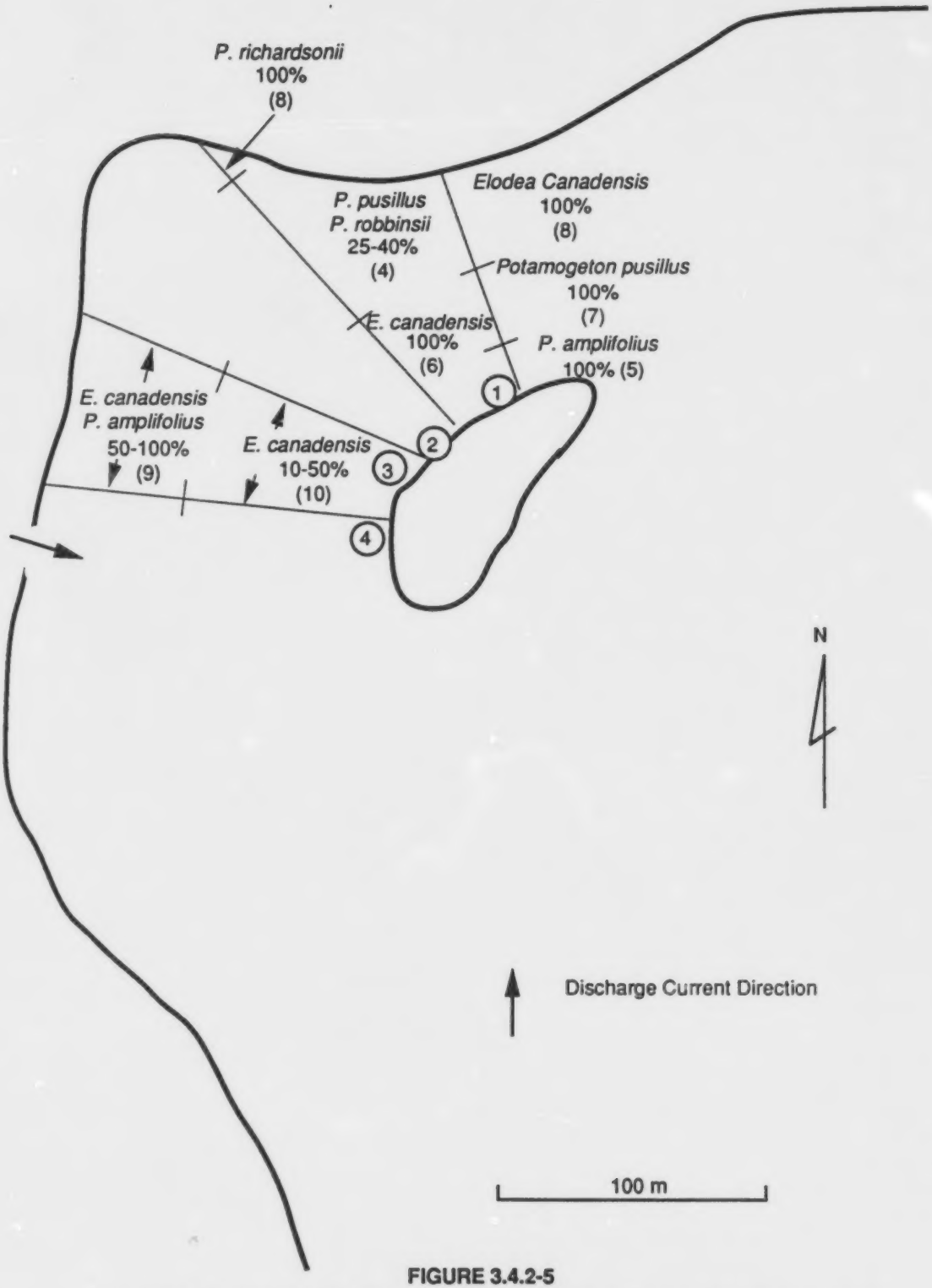


FIGURE 3.4.2-5

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) ALONG WESTERN SHORE OF SNOW LAKE, 1988

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West Bay of Icy Lake

The typical zonation pattern of emergent, floating-leafed to submergent dominance with distance from shore was obvious in this bay. The emergents in the bay consisted mainly of *Typha* spp and *Scirpus* spp. The most common floating-leafed forms in the north arm of the bay were *N. odorata* and *Sagittaria* spp, and in the southwestern area of the bay it was *N. odorata and Brasenia schreberi*.

In 1987 and 1988, the distribution of the submergent macrophytes, which has been on the increase since 1983, increased beyond the 1986 distribution and extended further east at the mouth of the bay at transect 17 (Figure 3.4.2-6 to 3.4.2-9). An area void of vegetation occurred beyond the point of entry of the discharge current into the bay where high siltation was observed (see Haymes 1989a for further discussion on siltation). This area was covered by submergent vegetation prior to 1987. Beyond this clear area, a large mat of heavy *P. robbinsii* growth extended across the bay along the water current circuit. In 1987 this patch only extended to the centre of the bay. A small patch of heavy growth of macrophytes in the water current in the west bay of Icy Lake was first observed in 1985.

The 1987 and 1988 cover and species diversity in the north arm of the bay was similar to that of 1986, with *P. robbinsii* the most common submergent macrophyte along Transects 1, 2, 3, 4 and 16. This species has also been prominent along Transects 5 and 6 since 1982. Cover has been heavy in the southwest of the bay, near the discharge current inlet since 1983 when an increase over the 1982 cover was observed (Haymes 1984). With the extended distribution of the macrophytes beyond transect 17, the cover along this transect had increased over that observed in 1986. *M. beckii* was prominent in the centre of the southern section of the bay intersected by transects 5, 7 and 17.

The macrophytes in the area where the discharge current enters the bay were covered with heavy growth of epiphytic algae similar to that found around the discharge inlet in the northwest bay in Snow Lake.

East Bay of Icy Lake

The 1987 distribution of macrophytes in the east bay of Icy Lake was similar to what it had been in 1985 and 1986 with heavy submergent growth in the west end of the bay and patchy growth in the eastern section (Figure 3.4.2-10 and 3.4.2-11). Discontinuous growth of emergents occurred along the shore while floating-leaf forms were found in the indentations of the shoreline and in occasional patches at deeper depths. In 1988 a discontinuous band of heavy submergent growth was observed in the discharge current along the length of the bay (Figure 3.4.2-12 and 3.4.2-13).

The distribution of macrophytes in the East bay of Icy Lake changed considerably between years during the 1981-1986 period. In 1981, submergents occurred along the shore, but the centre of the bay had been devoid of vegetation. In 1982, water levels were reduced by 1.5 m, and the macrophytes spread to the centre with heavy cover along the length of the bay. In 1983,

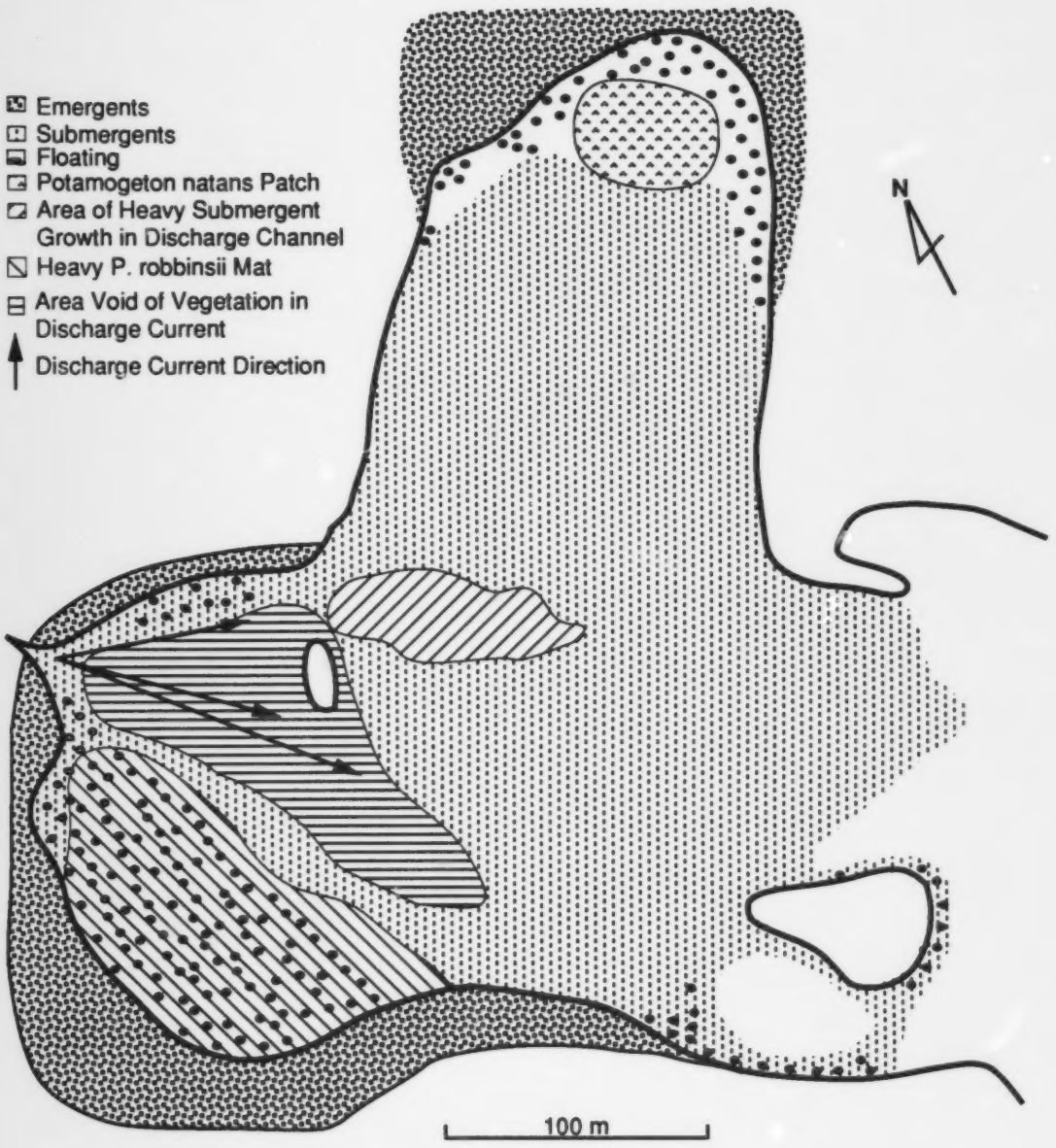

FIGURE 3.4.2-6
DISTRIBUTION OF MACROPHYTES IN WEST BAY OF ICY LAKE IN 1987

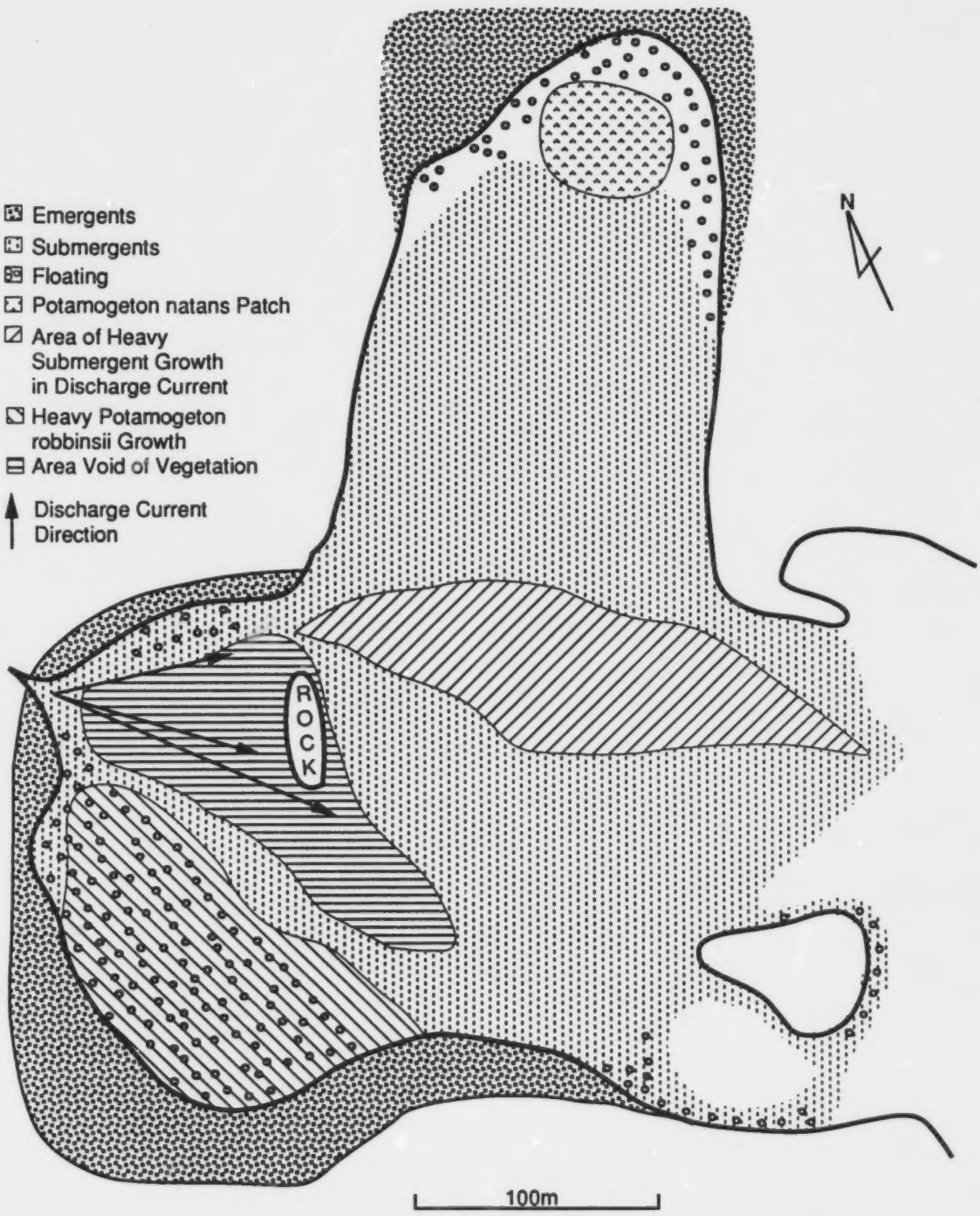

FIGURE 3.4.2-7
DISTRIBUTION OF MACROPHYTES IN WEST BAY OF ICY LAKE IN 1988

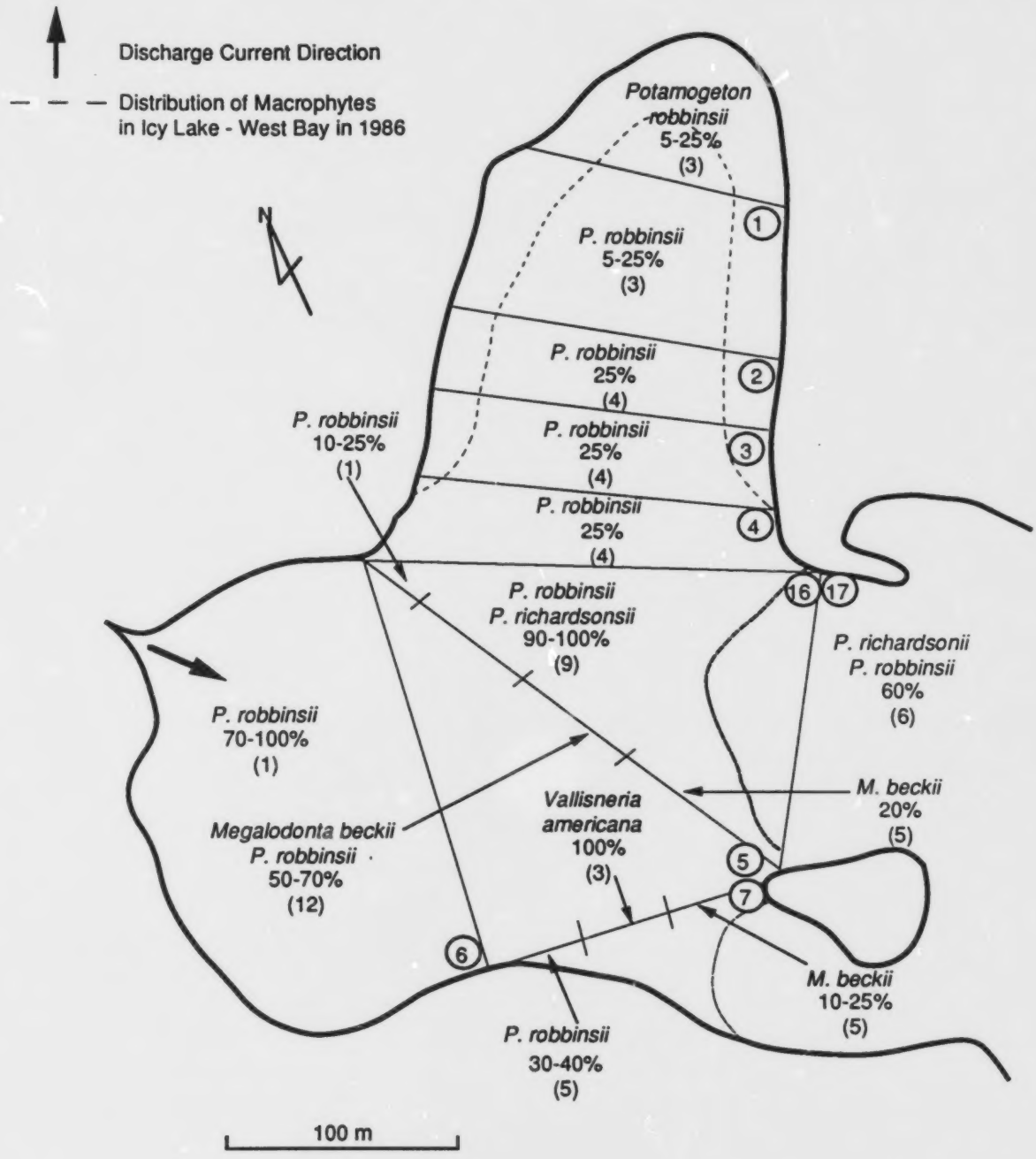

FIGURE 3.4.2-8

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (|—|) IN WEST BAY OF ICY LAKE, 1987

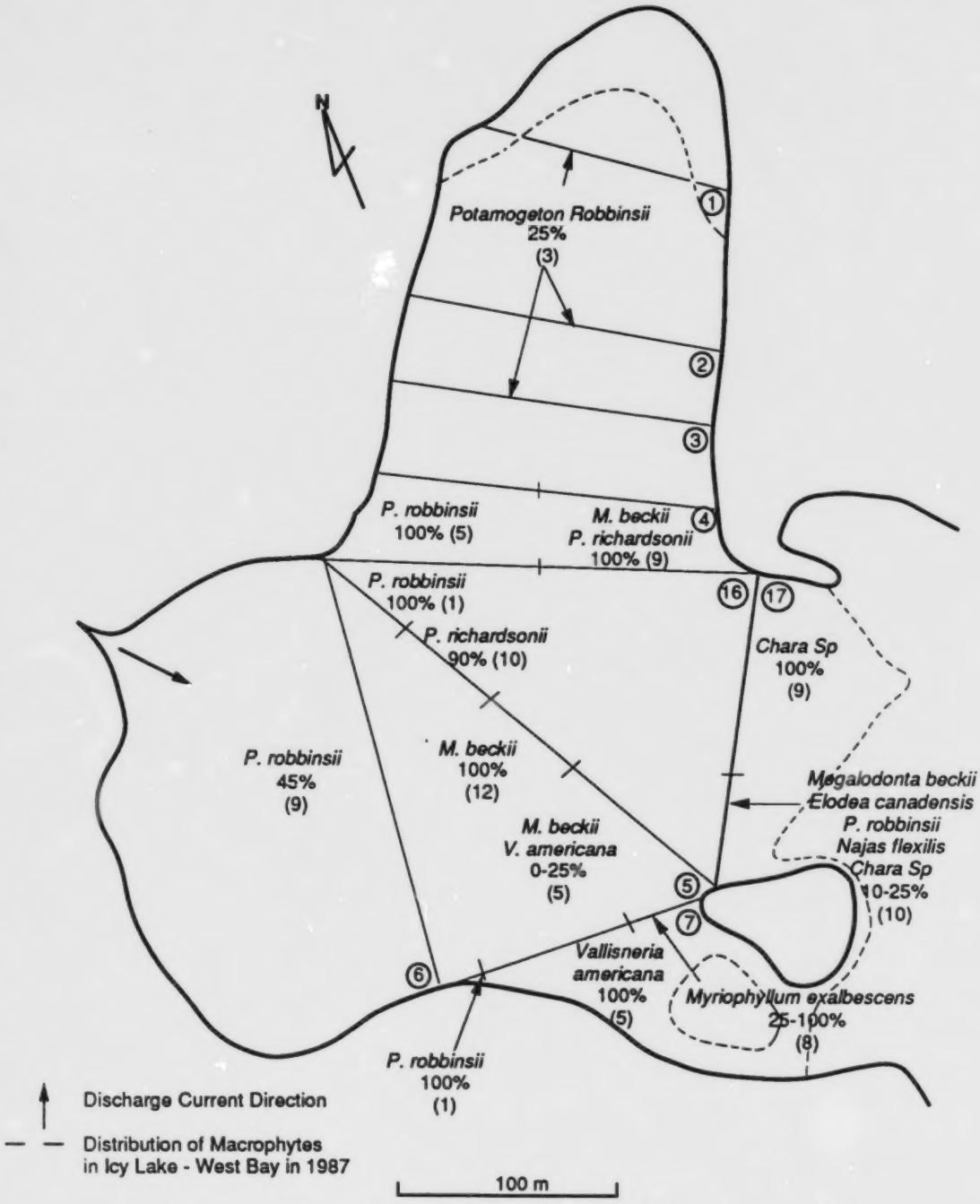

FIGURE 3.4.2-9
DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN WEST BAY OF ICY LAKE, 1988

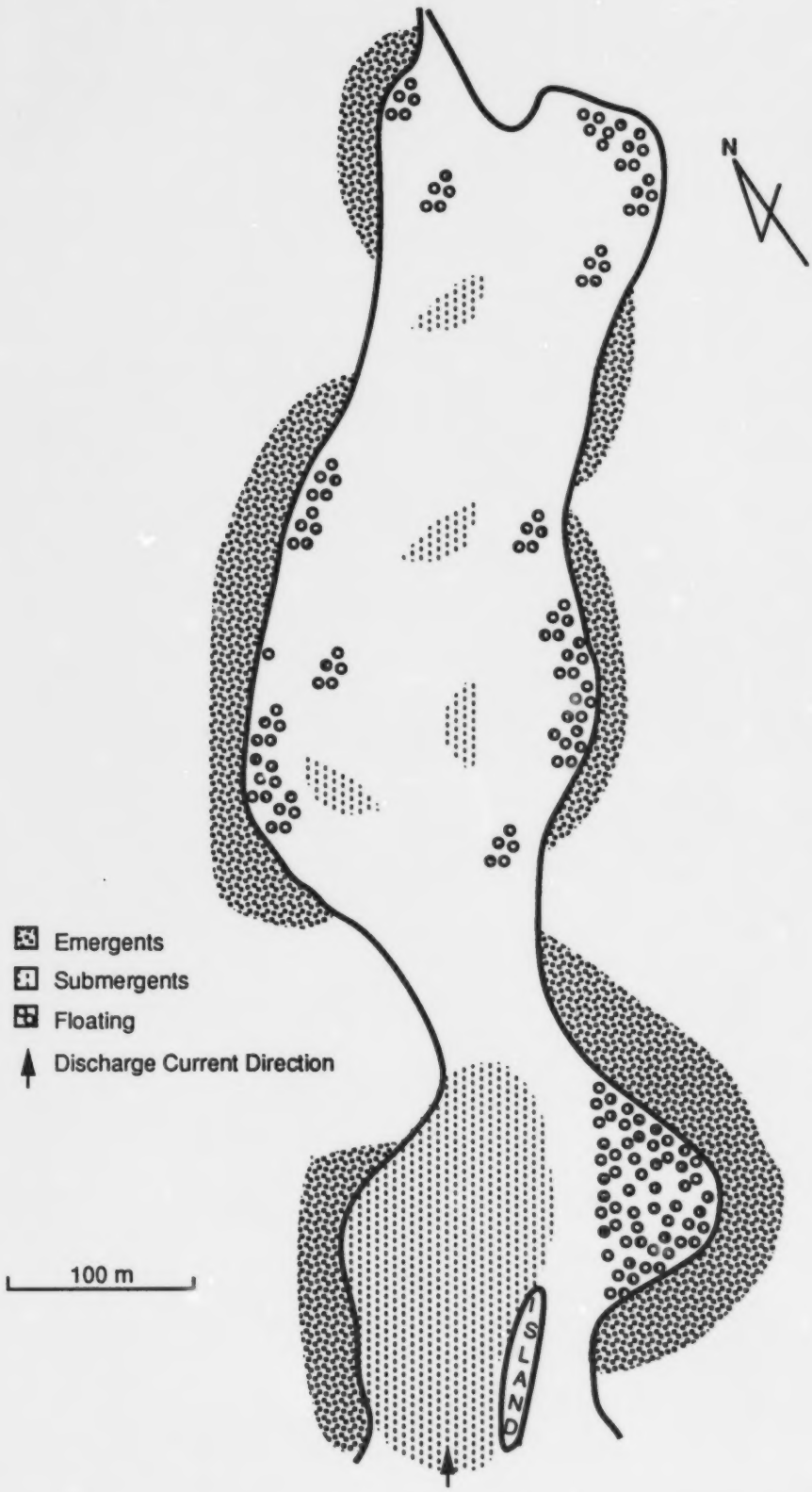

FIGURE 3.4.2-10
DISTRIBUTION OF MACROPHYTES IN EAST BAY OF ICY LAKE IN 1987

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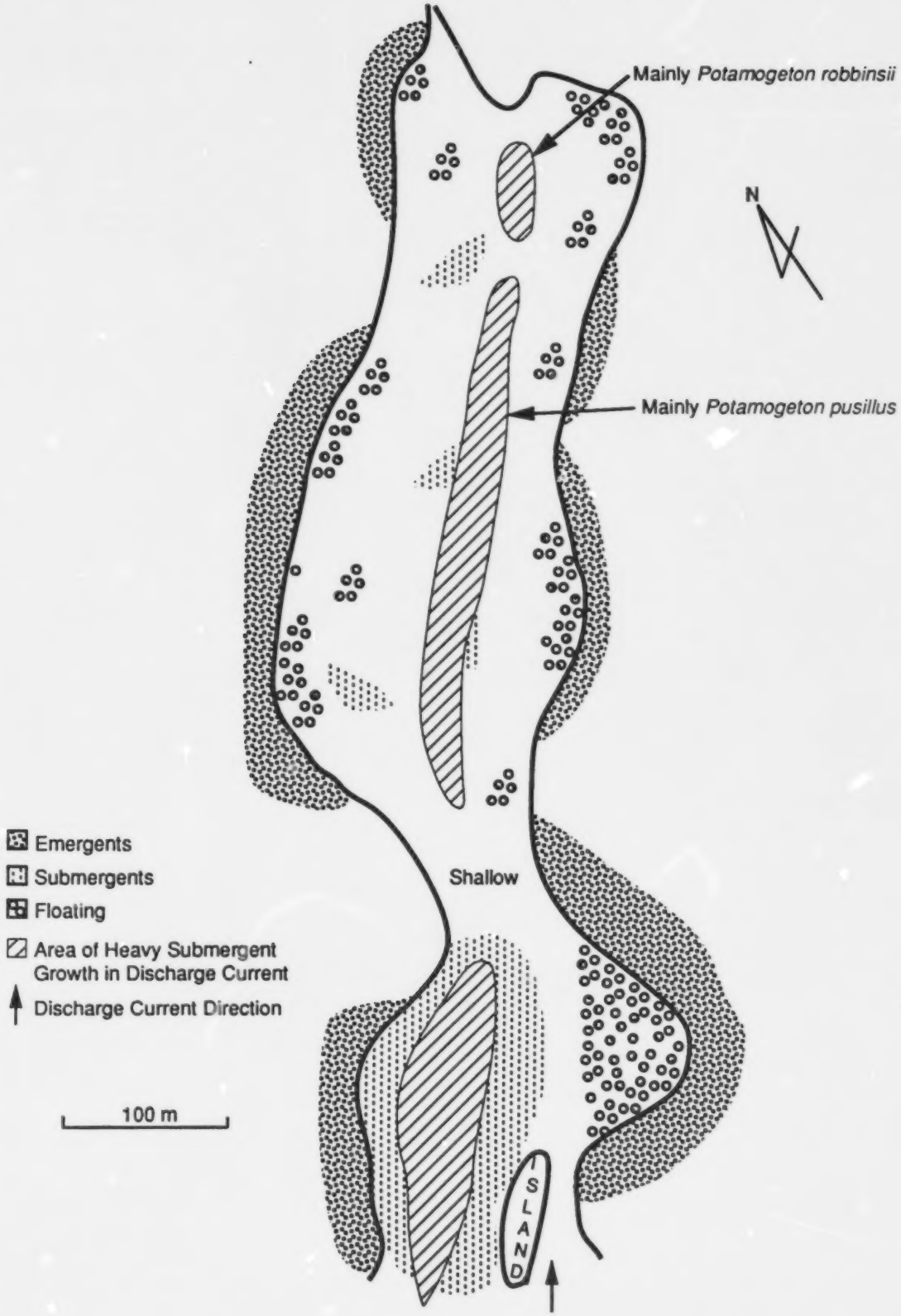

FIGURE 3.4.2-11
DISTRIBUTION OF MACROPHYTES IN EAST BAY OF ICY LAKE IN 1988

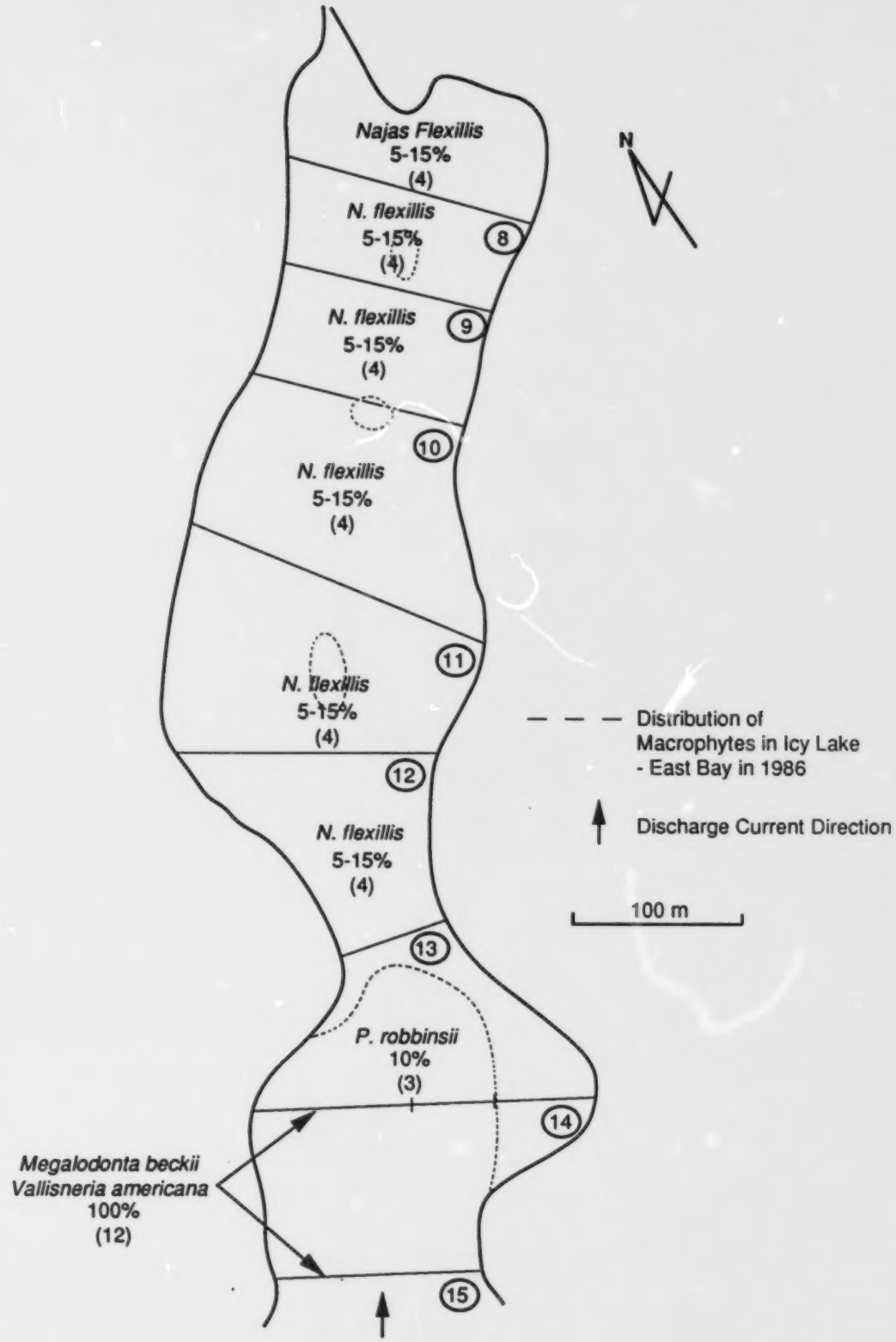

FIGURE 3.4.2-12
DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT SPECIES ( ) ON TRANSECT SEGMENTS (|—|) IN EAST BAY OF ICY LAKE, 1987

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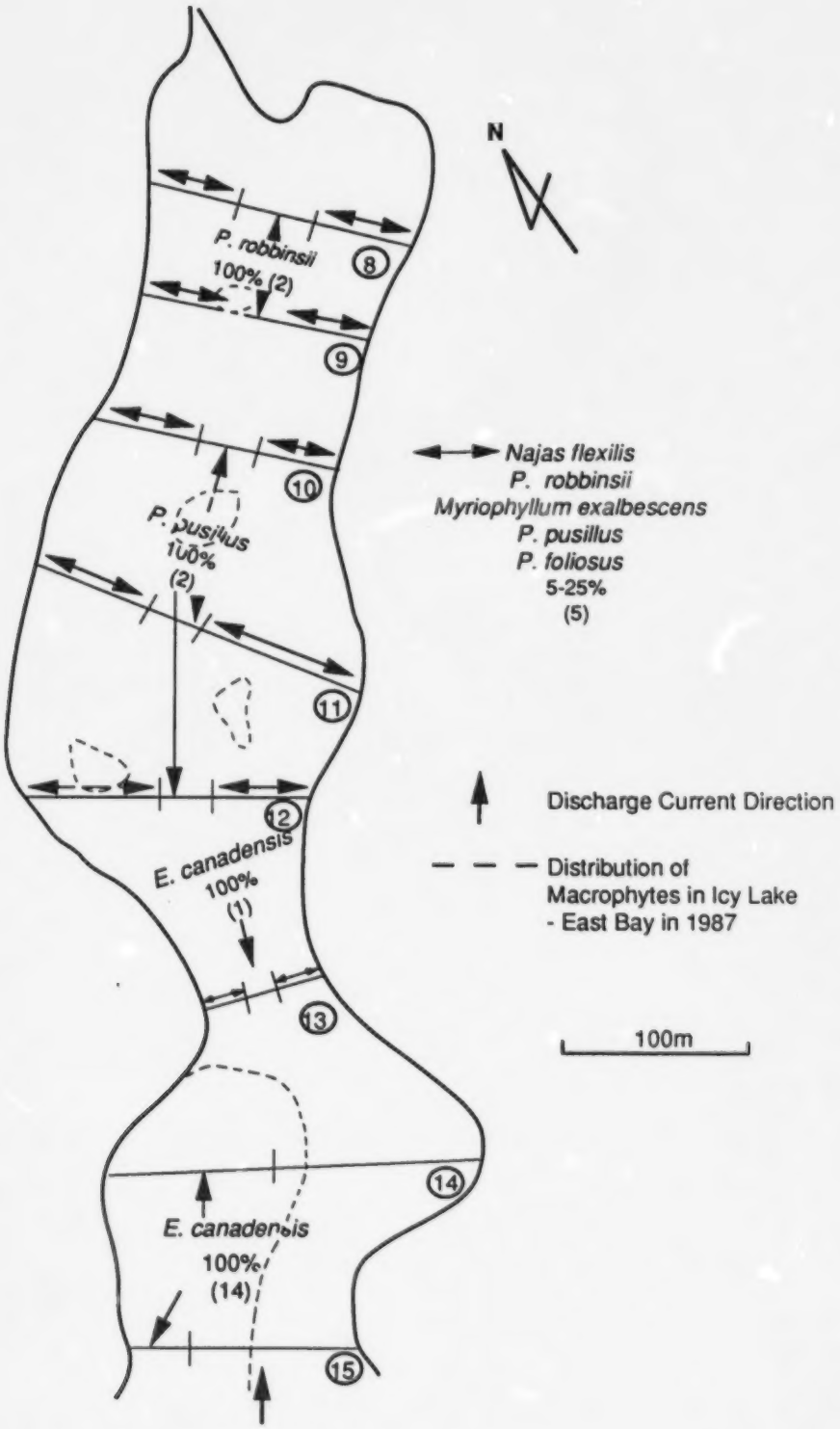

FIGURE 3.4.2-13

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN EAST BAY OF ICY LAKE, 1988

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the macrophytes were reduced to the occurrence of occasional patches. In 1985, an increase in cover was observed in the west-end of the bay where the discharge current enters the bay while cover in the east-end was confined to the occasional patch. In 1986, the distribution of macrophytes in the east bay was similar to what it had been in 1985, with smaller patches of growth in the east-end than had been observed in 1985. In 1986 siltation was very heavy in the eastern section of the bay, covering some of the submergent vegetation.

In 1987, sparse patches present in the east and central portions of the bay (Transects 8, 9, 10, 11, 12 and 13) were dominated by *N. flexilis* while *M. beckii, Vallisneria americana* and *P. robbinsii* were the most abundant forms in the west (Transects 14 and 15). The composition of the patches present in 1988 differed along the length of the patches with *E. canadensis* prominent in the west, *P. pusillus* in the centre portion and *P. robbinsii* in the east.

Species diversity was higher along the transects in the area of heavy growth in the west of the bay than along the transects in the centre and east portions of the bay as it had been since 1985.

Abie Lake

The distribution of macrophytes in the east basin of Abie Lake has increased steadily following water level stabilization in 1982. The vegetation in 1987 and 1988 extended westward along the shores beyond the western limit observed in 1986 (Figure 3.4.2-14 and 3.4.2-15). As in previous years, cover was heavy closer to shore and low in the centre of the basin.

Typha spp and Scirpus spp were the most common emergents and *N. odorata* was the most common floating-leafed form present in both years. Close to shore, the predominant submergents were *P. gramineus* along Transect 1, *Utricularia vulgaris* along Transect 2, and *P. robbinsii and N. flexilis* along Transects 3 and 4 (Figure 3.4.2-16). Further offshore, *P. robbinsii* was generally the most common species followed by *N. flexilis* in still deeper water. This spatial pattern with water depth has been observed in this basin since 1982.

The abundance of *N. flexilis* declined between 1981 and 1983 and then increased between 1983 and 1985 when it was the most common submergent in the bay. This species is among the vegetation described as choice duck food (Fassett 1975).

Slush Lake

As in all previous study years, the vegetation in Slush Lake in 1987 and 1988 was sparse. However, since 1986, the distribution had increased from the occasional small patch of emergents, lilies and pondweeds to slightly larger patches (Figure 3.4.2-17). The occurrence of submergents was still low and is due to the lack of suitable habitat resulting from the sharp drop in the shoreline of this lake.

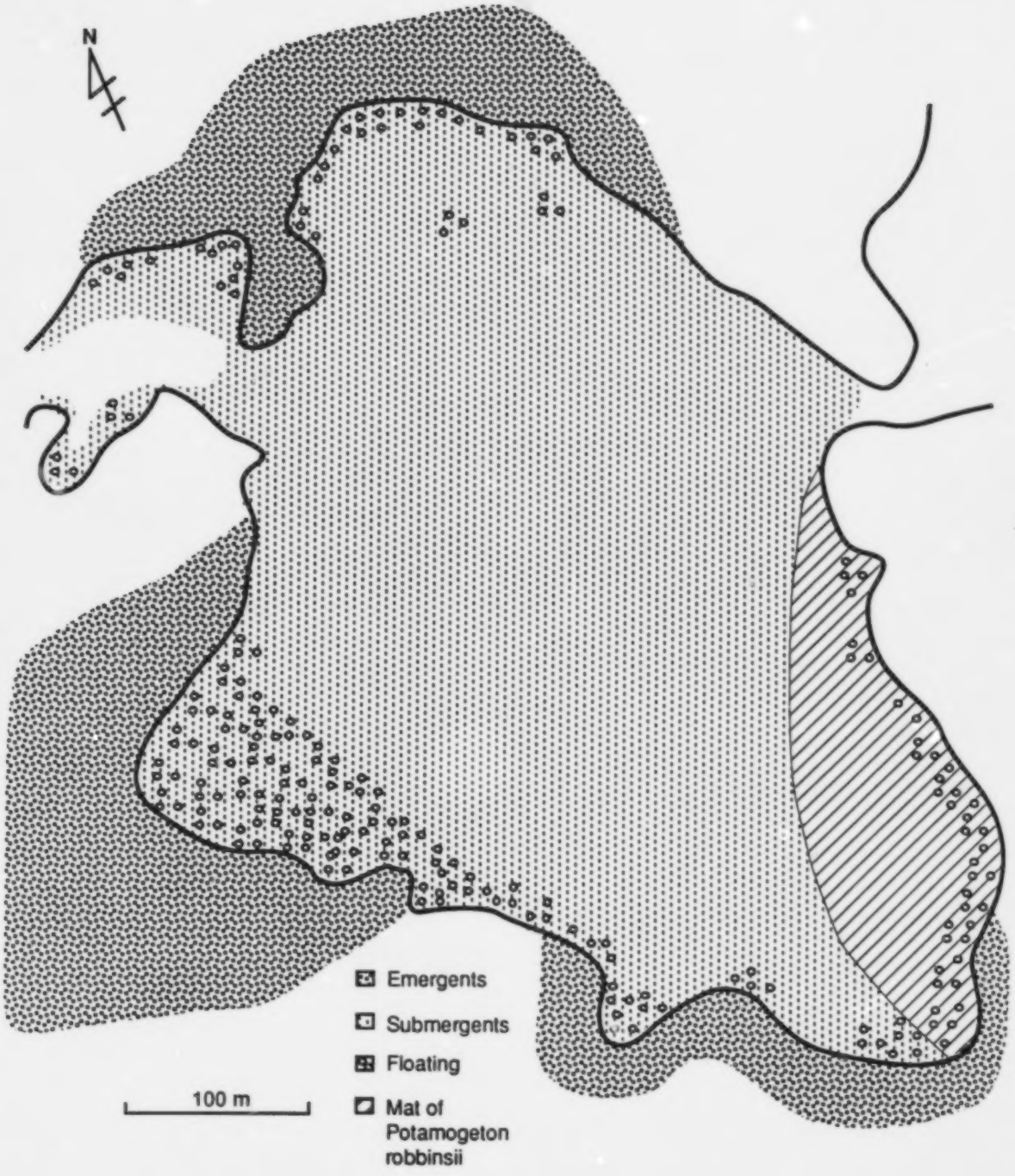

FIGURE 3.4.2-14

DISTRIBUTION OF MACROPHYTES IN EAST BASIN OF ABIE LAKE IN 1987

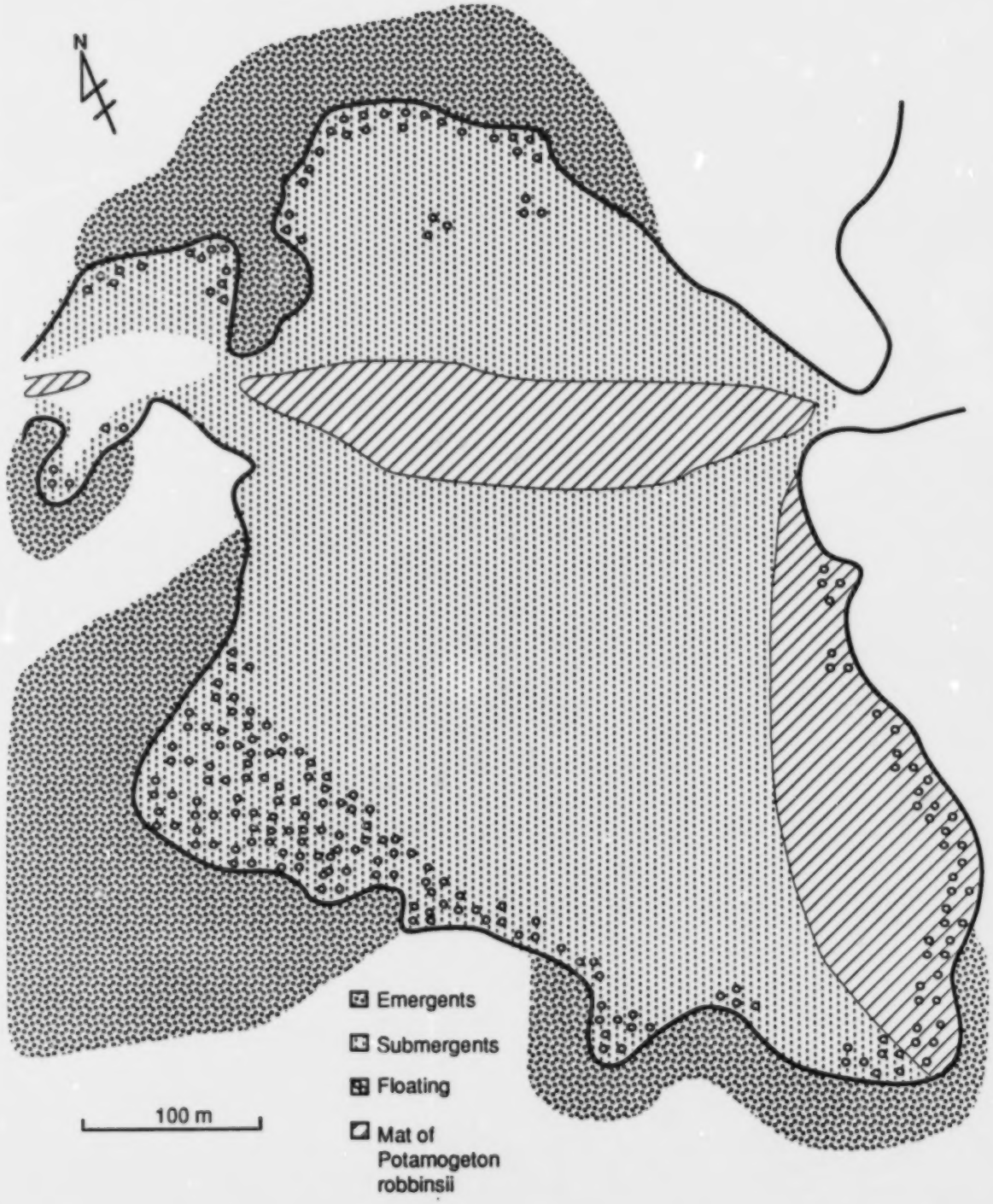

FIGURE 3.4.2-15
DISTRIBUTION OF MACROPHYTES IN EAST BASIN OF ABIE LAKE IN 1988

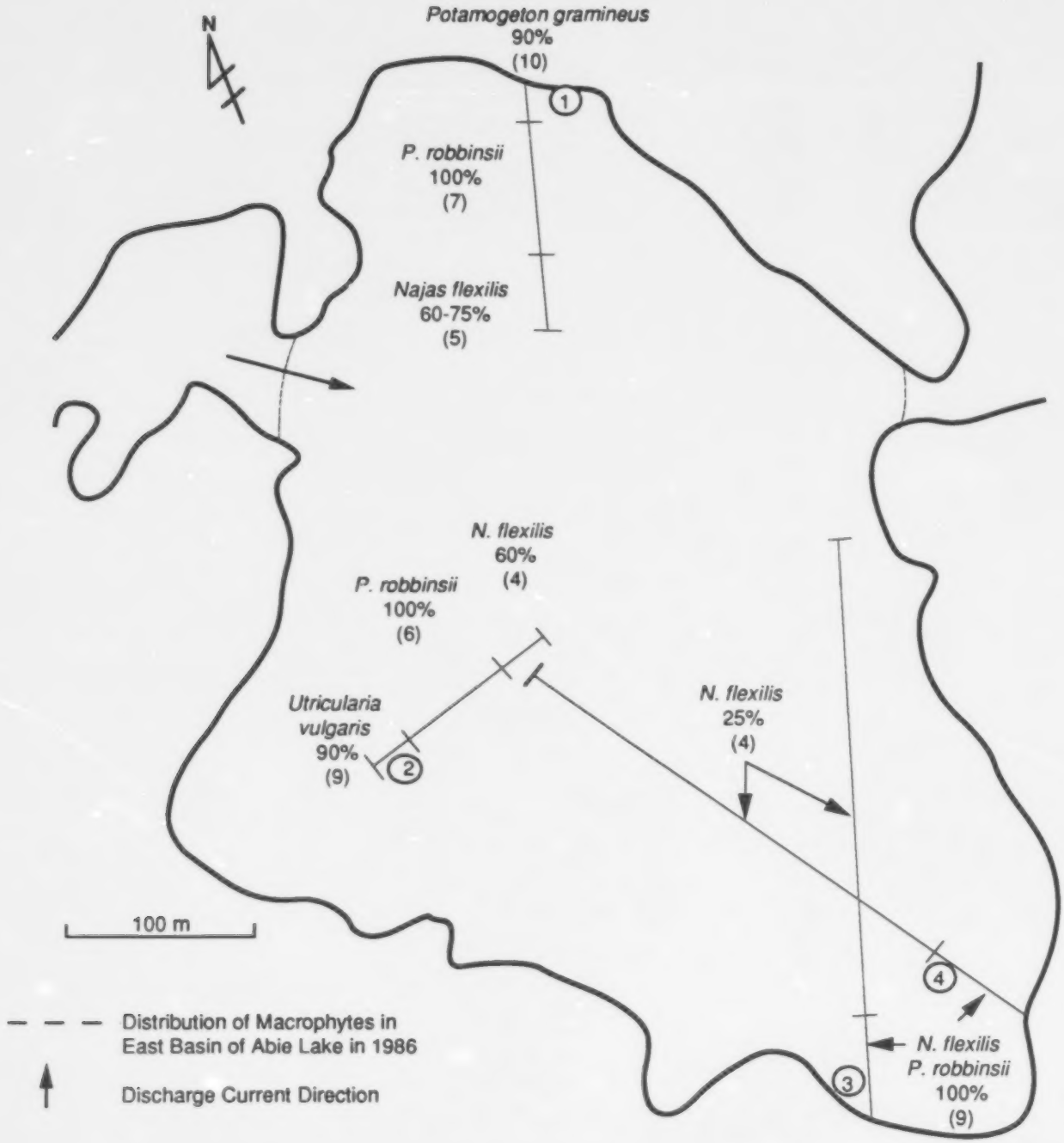

FIGURE 3.4.2-16

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN EAST BASIN OF ABIE LAKE, 1987 AND 1988

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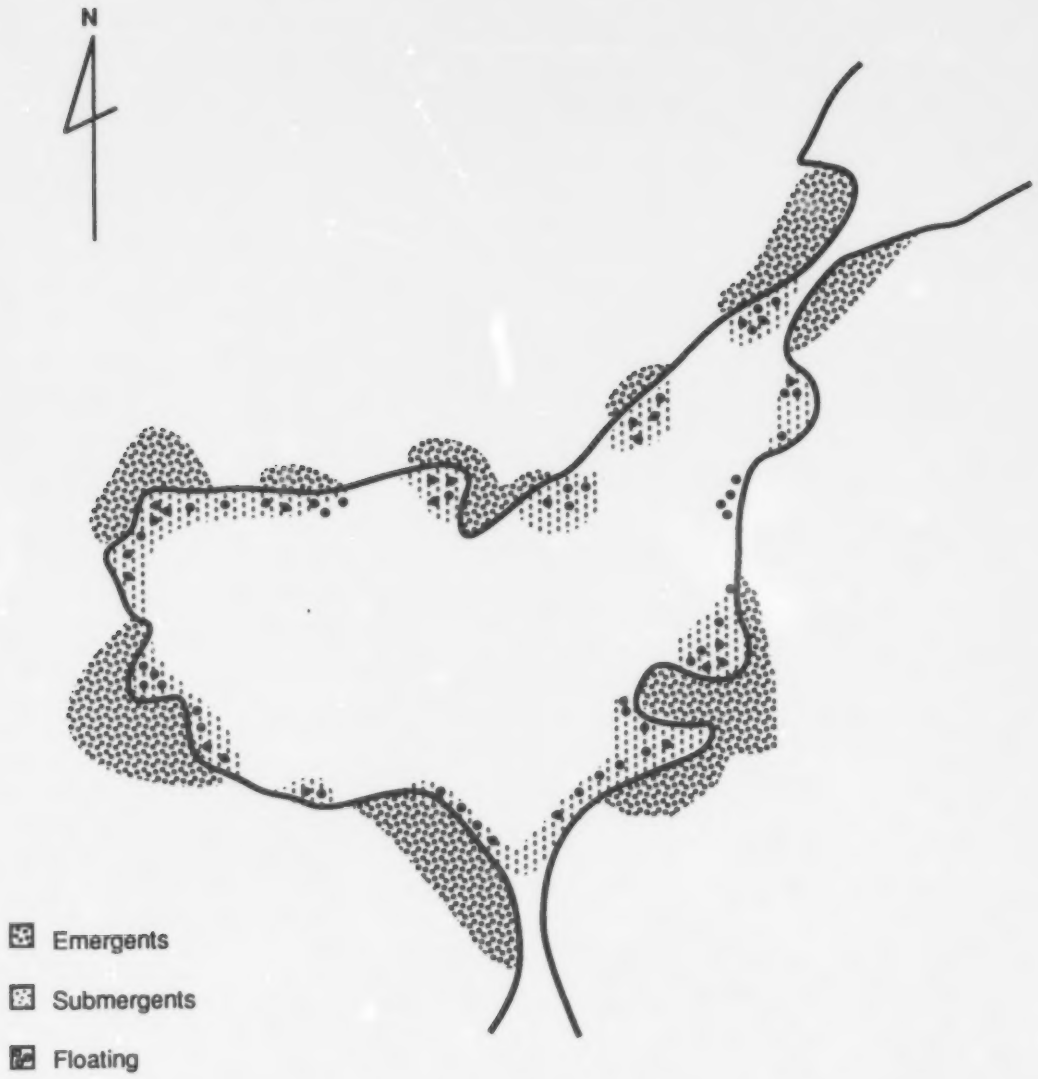

FIGURE 3.4.2-17

DISTRIBUTION OF MACROPHYTES IN SLUSH LAKE IN 1987 AND 1988

The most common macrophytes present in 1987 and 1988 were the emergents *Typha* spp and *Scirpus* spp, the floating-leafed form *N. odorata*, and the submergents *P. epihydrus* and *P. amplifolius*. *Sagittaria* spp was prominent in its floating-leafed form. These taxa were also the most common macrophytes present in 1986.

Marmion Lake Near Abie Lake

The distribution of the macrophytes in 1987 and 1988 in the area selected for special study in Marmion Lake near Abie Lake was similar to that of 1986 and had increased slowly between 1982, when water levels were stabilized, and 1986 (Figure 3.4.2-18 and 3.4.2-19). Cover was denser along the island than along the mainshore and has been since 1983. Species diversity was highest along the shore of the island.

The emergents along the island consisted of *Sagittaria* spp mixed in with *Scirpus* spp. On the mainshore the emergents consisted of *Scirpus* spp interspersed with *Chamaedaphne calyculata*. *N. odorata* was the main floating-leafed form along the island at Transect 1 while *Sagittaria* spp along with *N. odorata* were the main floating-leafed forms elsewhere.

P. richardsonii, although still present at the mainland along transect 3, was no longer the most abundant submergent as it had been in this area in previous years. The most common macrophyte present along the mainland in 1987 and 1988 was *P. robbinsii*. As in previous years *P. zosterifomis* was among the most common submergents present along the island together with *P. robbinsii* and *P. epihydrus*.

Marmion Lake Near Anderson Dam

The distribution of the macrophytes in this area in 1987 and 1988 had increased over that of 1986 extending further south along the west shore (Figures 3.4.2-20 and 3.4.2-21). In addition, vegetation occurred along the east shore where none had been observed in previous years. The emergents, which were confined to the northern portion of the west shore, consisted of a mixture of *Typha* spp, *Scirpus* spp, *Glyceria borealis*, *Sagittaria* spp, *Eleocharis acicularis* and *Juncus effusus*. The floating-leafed forms consisted mainly of *N. odorata* and *Sagittaria* spp.

The vegetation along all four transects was very heavy and species diversity was higher than it had been in previous years. The submergent, *Ceratophyllum demersum*, which was either dominant or co-dominant along the transects in 1986, was dominant along transects 1, 2, and 3, and was prominent along transect 4. *Ranunculus tricophyllus* which was prominent along transect 4 in 1986 formed a dense band close to shore in the area of transect 4. Beyond the lengths of the transects, *P. natans* and *P. richardsonii* were the most common forms present.

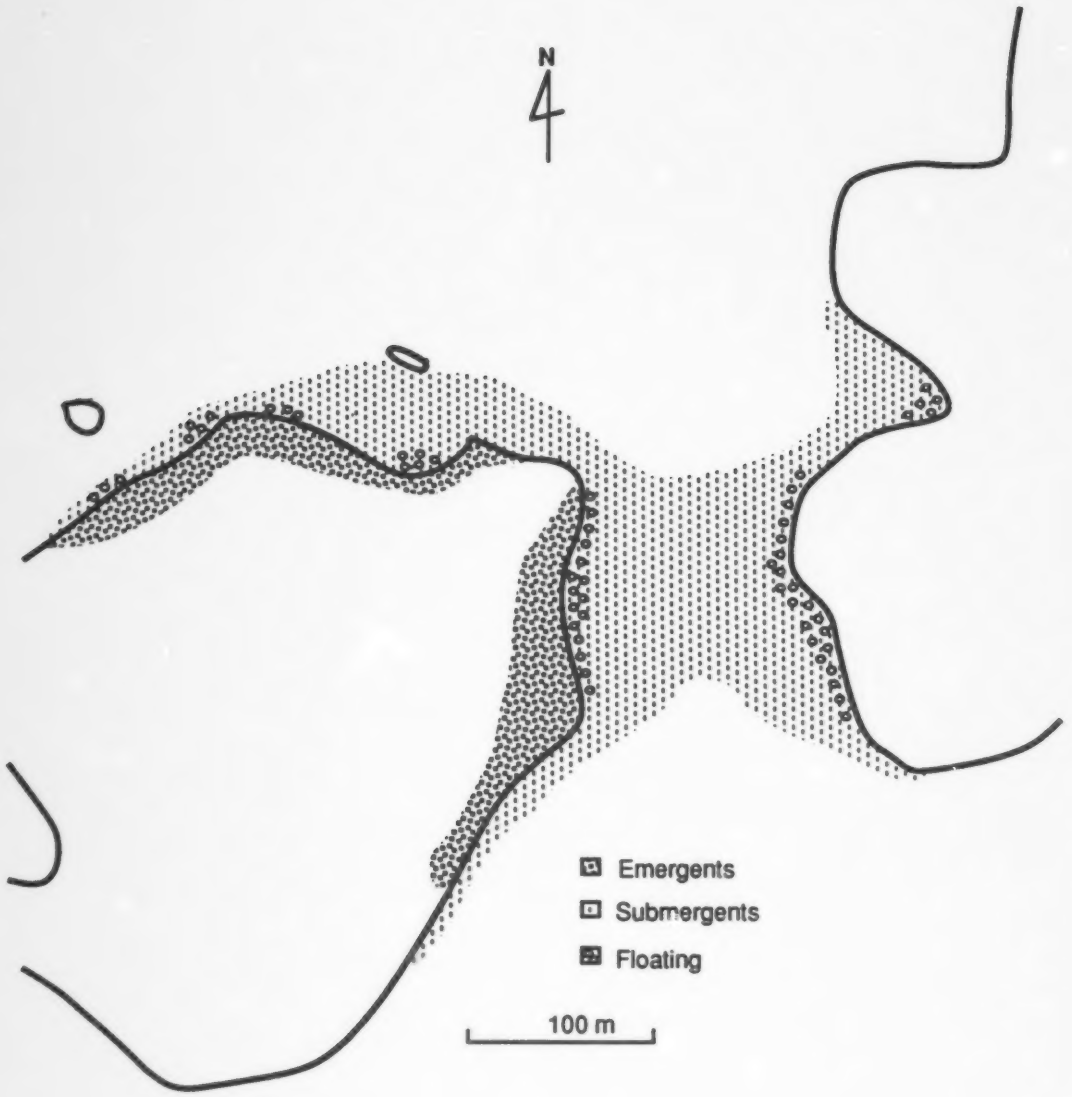

FIGURE 3.4.2-18
DISTRIBUTION OF MACROPHYTES IN MARMION LAKE NEAR ABIE LAKE IN 1987 AND 1988

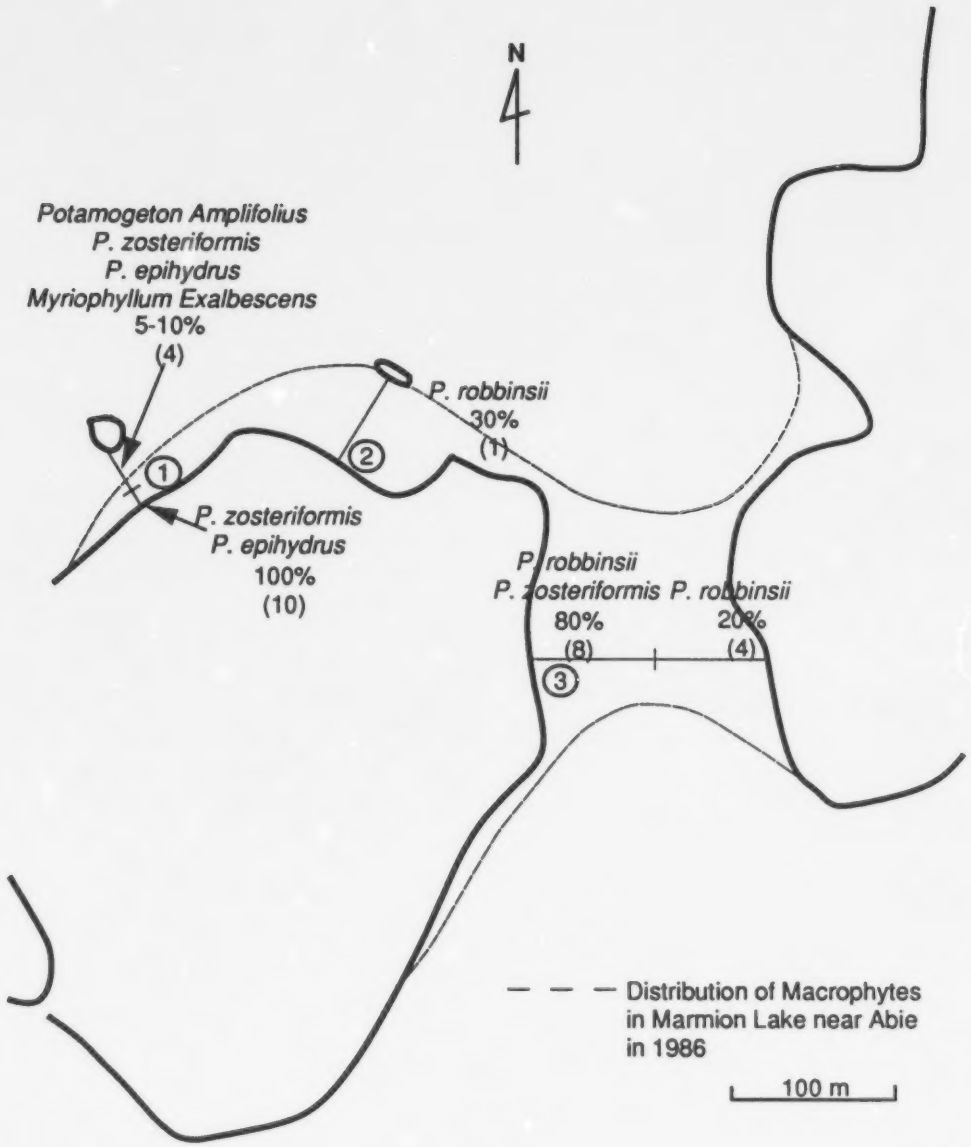

FIGURE 3.4.2-19

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES,AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN MARMION LAKE NEAR ABIE LAKE, 1987 AND 1988

FIGURE 3.4.2-20

DISTRICTION OF MACROPHYTES IN MARMION LAKE NEAR ANDERSON DAM IN 1987 AND 1988

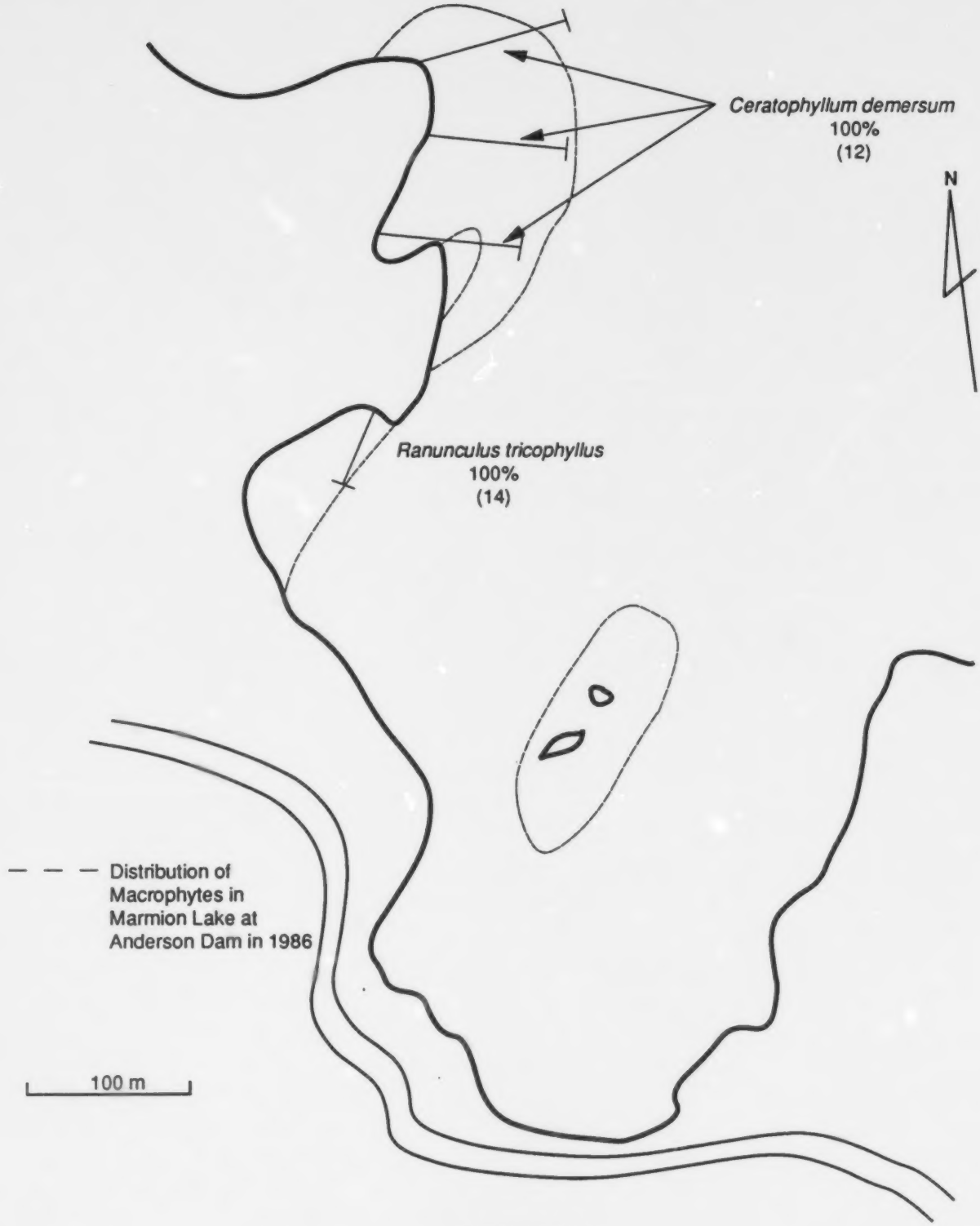

FIGURE 3.4.2-21

DOMINANT SUBMERGENT MACROPHYTES, PERCENT COVER OF SUBMERGENT MACROPHYTES, AND NUMBER OF SUBMERGENT MACROPHYTE SPECIES ( ) ON TRANSECT SEGMENTS (⊢⊣) IN MARMION LAKE NEAR ANDERSON DAM, 1987 AND 1988

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3.4.3 Overview

Possible effects of construction associated with the Atikokan TGS cooling circuit on the macrophytes of the cooling lakes were identified during the preoperational phase. These included the increased abundance of *Elodea canadensis* (Haymes 1986) and the disappearance of the water lilies from Snow Lake (Haymes 1987) as a result of the the lowering of the water level by 2-3 m in 1981-1982. The lowering of the water level allowed for the colonization of substrate which was not vegetated in 1981 while substrate exposed by the drawdown was taken over by emergents. With the raising of the water level between 1982 and 1983, *E. canadensis* spread to the shallow zone forming a discontinues band around Snow Lake in water 1-3 m deep. The distribution and density of the macrophytes in Snow Lake may also have been affected by sewage discharged through a marsh into a stream draining into the northwest corner of the lake during the preoperational period. The lowering of the water level in Icy Lake in 1982 resulted in an increase in the density of the submergents in the centre of the east bay of Icy Lake in that year. In 1983, lowered water levels in this bay may have caused extensive winterkill resulting in a marked reduction in the density of the submergents.

As hypothesized, there has been a gradual increase in the distribution of the macrophytes in the cooling circuit lakes since the stabilization of the water levels in 1982. In addition, the abundance of the macrophytes in some areas of Snow Lake, and in Icy and Abie Lakes had increased between 1985 and 1986, with still denser growth observed in 1987 and 1988. The increase in abundance in this part of the cooling circuit may, as hypothesized, be related to the thermal discharge. The increase in density was not as prominent in Snow Lake as in Icy and Abie lakes and may be related to the strong discharge current present in Snow Lake. Due to the heterogeneous distribution of the macrophytes, the increase in cover was not obvious along all of the transects established in the areas selected for special study in these three lakes.

Large mats of heavy growth of pondweeds, which first developed as small patches in 1985, were found along the cooling circuit in Icy and Abie lakes wherever suitable depth (1-3 m) and substrate occurred. Where these large mats of heavy vegetation occurred, the current was sluggish. In contrast, constricted areas along the cooling circuit where strong currents prevailed, such as the inlets of the west bays of Snow and Icy Lakes, were devoid of vegetation. Aquatic vegetation typically is sparse in strong currents and very dense in slow moving waters (Welch 1952).

Heavy siltation was apparent in Snow and Icy lakes, and to a lesser extend in Abie Lake. Increases in the distribution and abundance of macrophytes can result in increased siltation (Sculthorpe 1967) and were probably responsible for the increased siltation in Snow, Icy and Abie lakes.

In 1987 and 1988, heavy growth of epiphytic algae was obvious on the macrophytes growing along the cooling circuit at the current inlets at Snow and Icy Lakes and was probably related to both the higher temperature and current flow. An increase in the epiphytic algal standing crop, as a result of the discharge of thermal effluent, was also observed in the area of the Wabamun Power Station on Lake Wabamun, Alberta (Hickman 1974).

4.0 CONCLUSIONS

1. Alkalinity and primary production decreased in Snow, Icy and Abie Lakes and increased in Marmion Lake, between the pre- and postoperational studies. In 1983-1984, Snow, Icy and Abie lakes were classified as secondary eutrophic on the basis of mean and maximum primary production levels while Marmion and Slush were classified as intermediate between oligotrophic and mesotrophic, or in transition. In 1987-1988 all locations within the cooling circuit except Marmion South were classified as in transition. Levels at Marmion South were slightly higher than at the remaining locations within the cooling circuit and it was classified as secondary eutrophic. Slush Lake remained a borderline oligotrophic lake. The changes in the alkalinity and primary production of the lakes was attributed to mixing of water following the establishment of the cooling circuit which has resulted in a change in the trophic status of Snow, Icy and Abie Lakes.

2. The diatoms and flagellates were the most important phytoplankton in the study lakes in terms of biomass during both the pre- and postoperational studies. The relative abundance of the diatoms increased along the cooling circuit between Moose and Marmion Lakes while that of the flagellates decreased. A similar trend occurred in 1981, but not in 1983. Generally, phytoplankton biomass appears to have increased while species diversity appears to have decreased since 1981. These apparent differences may be part of natural variation and/or an artifact of infrequent sampling rather than a result of station operation since differences did not appear to be distinct between pre- and postoperational years.

3. The most common rotifers and crustacean zooplankton present in the study area during the preoperational studies in 1981 and 1983 remained the most common forms in the lakes in 1987. However, the relative abundance of *B.longirostris* and the cyclopoid copepods had declined between 1983 and 1987 and that of *D. galeata mendotae* had declined since 1981. The rotifers and crustacean zooplankton were most abundant in 1983 suggesting that the densities of the zooplankton have not increased since the implementation of the cooling circuit. Comparison of pre- and postoperational zooplankton data suggests that the discharge of sewage, liquid waste and cooling water from the station has not resulted in any obvious changes in the zooplankton of the study area that can be differentiated from year-to-year variation.

4. Possible effects of construction associated with the Atikokan TGS cooling circuit on the macrophytes in the cooling circuit were identified during the preoperational phase. These included the increased abundance of *E. canadensis* and the disappearance of the water lilies from Snow Lake as a result of the 1981-1982 water drawdown. The lowering of the water level at Icy Lake in 1982 resulted in increased density of the submergents in the centre of the bay between 1981 and 1982. In 1983, lowered water levels as a result of reduced flow into this bay may have caused extensive winterkill resulting in a marked reduction in the density of the submergents. There has been a gradual

increase in the distribution of the macrophytes in the lakes of the cooling circuit since the water stabilization in 1982. The density of the submergents have increased steadily since the station came on line in 1985. In addition, large mats of heavy growth of pondweeds, which were first observed as small patches in 1985, were found along the cooling circuit in Icy and Abie Lakes wherever suitable depth and substrate occurred. It is suggested that the increased distribution and density of macrophytes is responsible for heavy siltation observed in Snow, Icy and Abie lakes.

5.0 ACKNOWLEDGMENTS

The field work was carried out under the supervision of Ed Checko whose significant contribution we wish to acknowledge. The macrophyte study was designed and initiated by Mary K. Kirby, who also reported on the results of the preoperational studies. The Atikokan Aquatic Studies 1981-1988 were coordinated by G.T. Haymes.

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APPENDIX 1

Primary Production - Atikokan 1987-1988

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
June 1 [1987]	Marmion N	1	39.0	10.0	2.53	7.6	0.2	7.7	2.0
		2	39.0	10.0	2.53	4.7	0.2	4.9	3.7
		3	39.0	10.0	2.53	7.2	0.0	7.2	0.0
	Marmion S	1	40.0	10.4	2.63	4.3	0.1	4.4	2.4
		2	40.0	10.4	2.67	3.0	0.4	3.3	10.5
		3	40.0	10.4	2.70	1.3	0.5	1.8	26.8
	Abie	1	41.0	10.5	2.78	1.9	0.1	2.0	4.4
		2	41.0	10.5	2.83	4.1	0.1	4.3	3.0
		3	41.0	10.5	2.88	2.3	0.1	2.4	3.3
	Anderson Dam	1	39.0	9.8	2.78	4.5	0.0	4.5	0.0
		2	39.0	9.8	2.85	5.6	0.0	5.6	0.0
		3	39.0	9.8	2.90	5.5	0.1	5.7	2.3
	Slush	1	29.0	7.5	2.55	ns	0.0	ns	ns
		2	29.0	7.5	2.55	ns	0.2	ns	ns
		3	29.0	7.5	2.55	5.7	0.2	5.9	3.6
	Icy	1	39.0	10.0	2.43	5.3	0.0	5.3	0.0
		2	39.0	10.0	2.43	2.3	0.4	2.7	13.3
		3	39.0	10.0	2.43	4.5	0.3	4.9	6.5
	Snow	1	37.0	10.0	2.25	1.0	0.8	1.8	43.5
		2	37.0	10.0	2.25	5.5	0.1	5.7	2.6
		3	37.0	10.0	2.25	5.9	0.0	5.9	0.0
	Moose	1	40.0	9.9	2.77	4.5	3.8	8.4	45.6
		2	40.0	9.9	2.82	5.8	0.2	6.0	3.7
		3	40.0	9.9	2.88	5.9	0.3	6.2	5.4
	Control	1	41.0	10.5	2.77	ns	0.0	ns	ns
		2	41.0	10.5	2.82	ns	0.0	ns	ns
		3	41.0	10.5	1.93	ns	0.0	ns	ns

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
June 25-26 [1987]	Marmion N	1	36.5	9.1	2.10	3.1	6.8	9.8	68.7
		2	36.5	9.1	2.10	1.5	0.0	1.5	0.0
		3	36.5	9.1	2.10	0.0	0.0	0.0	0.0
	Marmion S	1	38.0	9.9	2.02	0.0	1.3	1.3	100.0
		2	38.0	9.9	2.02	0.0	11.2	11.2	100.0
		3	38.0	9.9	2.02	0.0	0.0	0.0	0.0
	Abie	1	38.5	9.6	2.50	1.6	0.4	2.0	20.0
		2	38.5	9.6	2.50	0.0	10.2	10.2	100.0
		3	38.5	9.6	2.50	0.0	0.0	0.0	0.0
	Anderson Dam	1	38.5	9.6	2.03	0.0	13.4	13.4	100.0
		2	38.5	9.6	2.03	0.0	14.1	14.1	100.0
		3	38.5	9.6	2.03	0.0	0.0	0.0	0.0
	Slush	1	24.5	6.4	2.43	0.0	0.0	0.0	0.0
		2	24.5	6.4	2.43	0.0	10.9	10.9	0.0
		3	24.5	6.4	2.43	1.9	2.3	4.1	55.2
	Icy	1	37.5	9.8	2.40	0.0	0.0	0.0	0.0
		2	37.5	9.8	2.40	0.0	0.0	0.0	0.0
		3	37.5	9.8	2.40	3.7	92.5	96.2	96.1
	Snow	1	36.5	9.1	2.28	0.4	0.0	0.4	0.0
		2	36.5	9.1	2.28	0.0	6.8	6.8	100.0
		3	36.5	9.1	2.28	1.5	15.8	17.3	91.4
	Moose	1	36.5	10.2	2.02	0.0	7.2	7.2	100.0
		2	36.5	10.2	2.02	7.6	0.0	7.6	0.0
		3	36.5	10.2	2.02	5.8	11.6	17.3	66.7
	Control	1	ERR	ERR	2.20	ERR	ERR	ERR	0.0
		2	85.5	18.8	2.20	50.3	0.0	50.3	0.0
		3	85.5	18.8	2.20	54.9	0.0	54.9	0.0

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
July 23-24 [1987]	Harmion N	1	31.0	7.4	2.33	4.8	0.5	5.3	9.5
		2	31.0	7.4	2.33	4.1	0.1	4.2	3.3
		3	31.0	7.4	2.33	4.3	0.2	4.5	4.6
	Harmion S	1	35.0	8.4	2.27	4.7	0.0	4.7	0.0
		2	35.0	8.4	2.27	5.3	0.1	5.4	2.1
		3	35.0	8.4	2.27	3.1	0.7	3.8	17.7
	Abie	1	39.5	9.5	2.02	6.6	0.4	7.0	6.1
		2	39.5	9.5	2.02	6.7	0.9	7.7	12.1
		3	39.5	9.5	2.02	4.6	0.5	5.1	9.5
	Anderson Dam	1	37.0	8.9	2.18	5.5	0.3	5.8	4.8
		2	37.0	8.9	2.18	4.1	0.1	4.2	3.1
		3	37.0	8.9	2.18	4.5	1.8	6.3	28.5
	Slush	1	20.0	4.8	2.02	0.4	0.5	0.9	57.4
		2	20.0	4.8	2.02	1.8	0.7	2.5	26.9
		3	20.0	4.8	2.02	0.0	0.3	0.3	93.7
	Icy	1	38.0	9.1	2.12	1.0	0.1	1.0	5.5
		2	38.0	9.1	2.12	2.0	0.0	2.0	0.0
		3	38.0	9.1	2.12	0.0	0.0	0.0	0.0
	Snow	1	36.0	8.6	2.12	4.4	0.3	4.6	5.5
		2	36.0	8.6	2.12	0.7	0.3	1.0	31.3
		3	36.0	8.6	2.12	3.5	0.2	3.7	5.6
	Moose	1	42.0	10.1	2.15	6.1	0.2	6.3	3.1
		2	41.5	10.0	2.15	3.0	0.4	3.4	11.2
		3	41.5	10.0	2.15	3.8	0.0	3.8	0.0
	Control	1	36.0	8.6	2.03	0.0	0.0	0.0	0.0
		2	35.5	8.5	2.03	0.0	0.0	0.0	0.0
		3	35.5	8.5	2.03	0.0	0.0	0.0	0.0

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
Aug. 11-12 [1987]	Harmion N	1	37.0	8.9	2.32	7.5	1.8	9.3	19.5
		2	37.0	8.9	2.32	4.2	0.5	4.7	10.2
		3	37.0	8.9	2.32	6.4	0.0	6.4	0.6
	Harmion S	1	36.0	8.6	2.30	9.8	0.0	9.8	0.0
		2	36.0	8.6	2.30	8.1	0.0	8.1	0.0
		3	36.0	8.6	2.30	7.9	0.9	8.8	9.7
	Abie	1	39.0	9.4	2.13	11.0	0.3	11.4	3.0
		2	38.5	9.2	2.13	12.0	0.0	12.0	0.0
		3	38.5	9.2	2.13	11.7	0.0	11.7	0.0
	Anderson Dam	1	38.0	9.5	2.22	11.3	0.0	11.3	0.0
		2	37.5	9.4	2.22	5.4	0.0	5.4	0.0
		3	37.5	9.4	2.22	10.2	0.0	10.2	0.0
	Slush	1	23.0	5.8	2.01	4.8	0.2	5.1	4.4
		2	23.0	5.8	2.01	4.7	0.0	4.7	0.0
		3	23.0	5.8	2.01	4.6	0.3	4.9	5.4
	Icy	1	38.0	9.1	2.18	7.1	0.0	7.1	0.0
		2	38.0	9.1	2.18	9.7	0.0	9.7	0.0
		3	38.0	9.1	2.18	4.4	0.0	4.4	0.0
	Snow	1	38.0	9.1	2.15	7.9	4.1	12.0	34.3
		2	38.0	9.1	2.16	8.5	0.0	8.5	0.0
		3	38.0	9.1	2.15	9.6	0.0	9.6	0.0
	Moose	1	39.0	9.8	2.10	5.1	0.0	5.1	0.0
		2	38.5	9.6	2.10	10.7	0.0	10.7	0.0
		3	38.5	9.6	2.10	10.1	0.6	10.7	5.2
	Control	1	36.0	8.6	2.00	0.0	0.0	0.0	0.0
		2	35.5	8.5	2.00	0.0	0.0	0.0	0.0
		3	35.5	8.5	2.00	0.0	0.0	0.0	0.0

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
Sept. 30 -	Marmion N	1	37.0	9.3	2.17	16.2	0.5	16.8	3.1
Oct. 1, 1987		2	36.5	9.1	2.17	16.7	0.0	16.7	0.2
		3	36.5	9.1	2.17	14.2	0.3	14.4	2.0
	Marmion S	1	36.0	9.0	2.12	16.7	0.6	17.3	3.3
		2	36.0	9.0	2.12	19.9	0.6	20.6	3.1
		3	36.0	9.0	2.12	21.1	0.9	22.0	4.1
	Abie	1	38.0	9.9	2.18	11.2	0.8	12.0	6.8
		2	38.0	9.9	2.18	12.2	0.6	12.8	5.0
		3	38.0	9.9	2.18	7.5	1.3	8.8	14.5
	Anderson Dam	1	37.0	9.3	2.00	18.1	0.6	18.6	3.1
		2	37.0	9.3	2.00	15.9	1.3	17.2	7.5
		3	37.0	9.3	2.00	10.1	1.1	11.2	10.2
	Slush	1	21.0	5.5	2.12	3.6	1.0	4.6	22.4
		2	21.0	5.5	2.12	7.2	0.7	7.9	8.8
		3	21.0	5.5	2.12	6.3	0.6	6.8	8.5
	Icy	1	40.0	10.4	2.12	12.1	0.7	12.7	5.2
		2	39.5	10.3	2.12	8.1	1.0	9.1	11.0
		3	39.5	10.3	2.12	11.4	0.9	12.3	7.1
	Snow	1	39.0	10.1	2.02	11.4	0.6	12.0	5.0
		2	39.0	10.1	2.02	8.1	0.4	8.5	4.9
		3	39.0	10.1	2.02	11.4	0.2	11.6	2.0
	Moose	1	37.0	8.9	2.32	11.9	0.4	12.3	3.2
		2	37.0	8.9	2.32	13.3	0.5	13.9	3.8
		3	37.0	8.9	2.32	16.0	0.7	16.6	4.1
	Control	1	36.0	9.0	2.35	0.0	0.0	0.0	0.0
		2	36.0	9.0	2.35	0.0	0.0	0.0	0.0
		3	36.0	9.0	2.35	0.0	0.0	0.0	0.0

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
Oct. 22-23 [1987]	Marmion N	1	36.0	9.4	2.12	7.7	0.8	8.4	9.3
		2	36.0	9.4	2.12	13.6	0.2	13.7	1.1
		3	36.0	9.4	2.12	21.1	0.3	21.4	1.3
	Marmion S	1	36.0	9.7	2.10	11.1	0.3	11.4	2.7
		2	36.0	9.7	2.10	17.2	0.0	17.3	0.3
		3	36.0	9.7	2.10	15.5	1.1	16.6	6.8
	Abie	1	38.0	9.5	2.07	12.8	0.5	13.3	3.9
		2	38.0	9.5	2.07	13.5	0.8	14.3	5.6
		3	38.0	9.5	2.07	11.5	0.3	11.9	2.6
	Anderson Dam	1	37.0	10.0	2.05	14.7	0.7	15.4	4.4
		2	37.0	10.0	2.05	14.7	0.6	15.3	3.7
		3	37.0	10.0	2.05	15.5	1.0	16.6	6.3
	Slush	1	21.0	5.5	2.07	7.7	0.3	8.0	4.0
		2	21.0	5.5	2.07	8.9	0.4	9.4	4.4
		3	21.0	5.5	2.07	8.9	0.2	9.2	2.6
	Icy	1	40.0	10.8	2.10	20.0	0.7	20.7	3.4
		2	40.0	10.8	2.10	10.5	0.2	10.8	2.2
		3	40.0	10.8	2.10	16.4	1.0	17.4	5.5
	Snow	1	36.0	9.4	2.07	7.3	0.9	8.1	10.8
		2	36.0	9.4	2.07	12.3	0.0	12.3	0.0
		3	36.0	9.4	2.07	10.6	0.6	11.3	5.6
	Moose	1	37.0	9.6	2.00	12.5	0.7	13.2	5.0
		2	37.0	9.6	2.00	13.1	0.5	13.5	3.3
		3	37.0	9.6	2.00	12.8	0.7	13.5	5.4
	Control	1	36.0	9.7	2.00	0.0	0.0	0.0	0.0
		2	36.0	9.7	2.00	0.0	0.0	0.0	0.0
		3	36.0	9.7	2.00	0.0	0.0	0.0	0.0

APPENDIX 1

PRIMARY PRODUCTION - ATIKOKAN 1987-1988

Date	Lake	Rep	Tot. Alkal. mg/L CaCO3	D.I.C. mg C/L	Time hours	Cellular C mg C/m3/h	Extracell. C mg C/m3/h	Prim. Prod. mg C/m3/h	% Extracell. Release
March 3, [1988]	Harmion N	1	41.0	10.7	2.17	4.7	0.0	4.7	0.0
		2	41.0	10.7	2.17	6.3	0.0	6.3	0.0
		3	41.0	10.7	2.17	5.1	0.0	5.1	0.8
	Harmion S	1							
		2							
		3							
	Abie	1	42.0	11.3	2.17	6.1	0.0	6.1	0.0
		2	42.0	11.3	2.17	6.5	0.0	6.5	0.0
		3	42.0	11.3	2.17	9.1	0.0	9.1	0.0
	Anderson Dam	1	42.0	11.3	2.08	1.6	0.0	1.6	0.0
		2	42.0	11.3	2.08	2.1	0.0	2.1	0.0
		3	42.0	11.3	2.08	6.3	0.0	6.3	0.0
	Slush	1							
		2							
		3							
	Icy	1	42.0	11.3	2.02	0.0	0.0	0.0	0.0
		2	42.0	11.3	2.02	6.0	0.0	6.0	0.0
		3	42.0	11.3	2.02	3.9	0.0	3.9	0.0
	Snow	1	41.0	11.1	2.00	4.9	0.0	4.9	0.0
		2	41.0	11.1	2.00	5.8	0.0	5.8	0.0
		3	41.0	11.1	2.00	6.8	0.0	6.8	0.0
	Moose	1							
		2							
		3							
	Control	1	43.0	11.2	2.03	0.0	0.0	0.0	0.0
		2	43.0	11.2	2.03	0.0	0.0	0.0	0.0
		3	43.0	11.2	2.03	0.0	0.0	0.0	0.0

APPENDIX 2

May-October 1987
Atikokan Phytoplankton Biomass (Mg/m^3)

APPENDIX 2

MAY 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MG/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	0	0	0	0	0	0	0	0
Oscillatoria sp	0	0	0	0	0	0	168	0
Aphanizomenon flos-aquae	0	0	7	0	0	0	0	0
Microcystis	0	0	0	0	0	0	0	0
Merismopedia sp	0	0	0	0	0	0	0	0
Ankistrodesmus falcatus	30	64	11	30	0	0	15	8
Ankistrodesmus mirabilis	1	0	0	0	0	0	10	1
Cosmarium sp	0	0	0	0	0	0	0	0
Elakatothrix gelatinosa	5	0	5	10	0	15	0	0
Oocystis sp	225	100	13	125	125	75	190	0
Scenedesmus bijuga	0	0	0	0	8	0	0	0
Closterium sp	0	0	0	690	0	0	0	0
Kirchneriella sp	0	15	0	0	0	0	0	0
Franceia sp	0	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	0	0	0
Mougeotia sp	0	0	0	0	0	0	0	0
Crucigenia sp	0	0	0	0	0	0	0	0
Lagerheimia sp	0	0	0	0	0	0	0	0
Selenastrum sp	0	0	0	0	0	0	0	0
Golenkinia sp	0	0	0	0	0	0	0	0
Tetraedron sp	380	333	48	0	380	380	0	333
Peridinium sp	0	0	0	0	0	0	0	0
Ceratium hirundinella	0	0	0	0	0	0	0	0
Cryptomonas sp	2464	528	704	2816	1408	528	2112	1232
Rhodomonas minuta	1309	838	506	968	561	1397	2684	2463
Dinobryon sp	418	304	318	219	361	86	2242	162
Asterionella gracillima	672	1120	400	1600	1376	207	640	448
Cyclotella sp	90	0	68	203	203	0	90	0
Cymbella sp	0	0	0	0	0	0	0	0
Diatoma sp	0	0	0	0	38	0	0	0
Fragilaria sp	30	0	0	0	0	0	0	0
Fragilaria crotonensis	0	0	36	68	216	0	0	56
Melosira sp	0	2913	0	6757	350	117	0	1515
Melosira granulata	0	0	0	0	0	0	0	0
Navicula sp	0	0	0	0	0	0	0	0
Pennales	450	350	150	300	1000	50	300	400
Rhizosolenia sp	750	300	150	450	1200	300	0	300
Rhoicosphenia curvata	0	0	0	0	0	0	0	127
Stephanodiscus sp	4	0	4	55	9	17	60	4
Stephanodiscus binderanus	0	0	0	0	0	0	0	0
Stephanodiscus niagarae	0	0	0	0	1037	0	0	0
Tabellaria sp	0	0	0	0	0	0	0	0
Tabellaria fenestrata	250	150	125	250	500	125	250	250
Synedra sp	100	0	0	0	0	50	2500	50

APPENDIX 2

JUNE 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MG/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	59	65	46	78	26	0	26	182
Oscillatoria sp	0	0	0	0	0	0	0	0
Aphanizomenon flos-aquae	0	0	0	0	0	0	0	0
Microcystis sp	0	8	16	40	12	16	80	0
Merismopedia sp	0	0	0	0	0	22	0	0
Ankistrodesmus falcatus	0	0	0	0	8	0	0	0
Ankistrodesmus mirabilis	0	0	0	0	0	0	0	0
Cosmarium sp	0	0	33	330	0	0	0	0
Elakatothrix gelatinosa	0	10	25	0	0	10	0	10
Oocystis sp	50	0	150	75	0	200	125	25
Scenedesmus bijuga	16	0	4	4	0	0	0	0
Closterium sp	0	0	0	0	0	0	0	0
Kirchneriella	0	0	0	0	0	0	0	0
Franceia	49	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	0	0	0
Mougeotia sp	0	0	0	0	0	0	0	0
Crucigenia	14	7	0	0	0	4	0	4
Lagerheimia	0	13	0	13	0	8	0	0
Selenastrum sp	0	0	60	0	0	0	0	0
Golenkinia	0	0	0	0	0	0	258	0
Tetraedron	95	95	143	95	190	238	48	0
Peridinium sp	0	0	83	83	166	166	0	83
Ceratium hirundinella	0	0	0	0	0	0	0	0
Cryptomonas	2288	0	176	880	1408	352	176	1760
Rhodomonas minuta	688	1288	713	888	825	825	500	563
Dinobryon sp	855	304	1112	390	437	599	238	998
Asterionella gracillima	64	0	160	224	32	64	0	32
Cyclotella sp	0	0	0	0	0	0	90	0
Cymbella sp	0	0	0	0	50	50	0	0
Diatoma sp	0	0	0	0	0	0	0	0
Fragilaria sp	600	0	0	0	38	0	0	0
Fragilaria crotonensis	0	80	0	0	0	0	0	0
Melosira sp	0	0	0	816	1165	0	0	0
Melosira granulata	0	0	0	0	0	0	0	0
Navicula s	0	0	0	0	0	0	0	0
Pennales	250	150	0	400	750	150	0	350
Rhizosolenia sp	900	0	0	1200	150	300	0	750
Rhoicosphenia curvata	0	0	0	0	0	0	0	0
Stephanodiscus	4	60	0	0	9	13	64	0
Stephanodiscus binderanus	0	0	0	0	0	0	0	0
Stephanodiscus niagarae	0	0	0	0	0	0	0	0
Tabellaria sp	0	0	0	0	0	0	0	0
Tabellaria fenestrata	0	0	125	375	0	875	1375	0
Synedra sp	0	0	0	0	0	0	50	0

APPENDIX 2

JULY 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MG/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	0	130	0	52	299	260	0	104
Oscillatoria sp	0	0	0	0	0	0	0	0
Aphanizomenon flos-aquae	46	0	0	0	330	17	195	0
Microcystis sp	0	16	40	88	144	0	272	16
Merismopedia sp	0	0	0	0	0	0	0	0
Ankistrodesmus falcatus	0	0	0	0	0	0	0	0
Ankistrodesmus mirabilis	0	0	0	0	0	0	0	2
Cosmarium sp	2	0	0	0	0	0	0	0
Elakatothrix gelatinosa	0	0	0	0	0	0	0	5
Oocystis sp	0	20	20	10	0	0	400	0
Scenedesmus bijuga	0	0	150	200	0	0	0	0
Closterium sp	0	0	0	0	8	12	24	8
Kirchneriella sp	0	0	4140	0	0	0	0	0
Franceia	0	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	0	0	0
Mougeotia sp	0	0	0	0	0	0	0	0
Crucigenia sp	0	0	0	0	0	0	0	0
Lagerheimia sp	0	14	11	0	0	7	0	4
Selanastrum sp	0	25	0	0	0	0	0	2
Golenkinia sp	0	0	0	0	0	0	0	0
Tetraedron sp	0	0	0	0	0	0	0	0
Peridinium sp	0	190	0	0	190	95	190	0
Ceratium hirundinella	0	0	830	0	1660	830	0	0
Cryptomonas sp	2464	0	0	3500	0	0	0	0
Rhodomonas minuta	3432	2266	1056	1056	3168	1232	1056	1936
Dinobryon sp	779	608	1100	1892	1694	1188	374	572
Asterionella gracillima	768	0	314	1026	1026	228	76	238
Cyclotella sp	0	0	512	576	576	992	0	480
Cymbella sp	0	0	0	0	0	0	0	0
Diatoma sp	38	0	0	0	0	0	0	0
Fragilaria sp	0	0	19	0	0	0	0	19
Fragilaria crotonensis	0	160	0	0	300	0	0	0
Melosira sp	0	0	0	80	0	0	0	0
Melosira granulata	0	0	932	0	0	0	0	0
Navicula sp	100	0	0	0	0	0	0	0
Pennales	500	300	0	0	0	0	0	0
Rhizosolenia sp	300	0	200	500	700	400	200	250
Rhoicosphenia curvata	0	0	600	0	300	1200	300	150
Stephanodiscus sp	0	119	0	0	0	0	0	63
Stephanodiscus binderanus	2700	0	0	145	0	0	0	21
Stephanodiscus niagarae	0	0	1037	0	0	0	0	0
Tabellaria sp	500	0	0	0	0	0	0	0
Tabellaria fenestrata	0	0	625	250	0	0	1750	0
Synedra sp			0	0	0	0	100	0

APPENDIX 2

AUGUST 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MG/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	1365	78	839	1495	143	325	436	202
Oscillatoria sp	0	0	0	0	0	0	0	0
Aphanizomenon flos-aquae	297	0	330	314	33	59	0	0
Microcystis sp	0	80	248	192	80	0	416	64
Merismopedia sp	0	0	0	0	0	0	0	0
Ankistrodesmus falcatus	30	8	0	0	0	0	0	0
Ankistrodesmus mirabilis	0	0	0	0	0	0	0	0
Cosmarium sp	0	0	0	0	0	0	0	0
Elakatothrix gelatinosa	20	15	0	20	20	30	0	10
Oocystis sp	300	0	0	0	0	0	88	0
Scenedesmus bijuga	56	4	4	24	4	0	8	20
Closterium sp	0	0	0	0	0	0	0	0
Kirchneriella sp	0	0	0	0	0	0	0	0
Franceia	0	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	320	0	0
Mougeotia sp	0	0	0	0	0	351	0	0
Crucigenia sp	14	11	21	28	14	28	0	7
Lagerheimia sp	0	0	0	0	0	0	0	0
Selenastrum sp	0	0	0	0	0	0	0	0
Golenkinia sp	0	0	0	0	0	0	0	0
Tetraedron sp	0	0	0	0	0	0	0	0
Peridinium sp	1660	0	0	0	830	1660	1660	0
Ceratium hirundinella	0	0	0	0	0	0	0	0
Cryptomonas sp	1408	1232	880	1760	2816	10208	352	1408
Rhodomonas minuta	1254	880	803	1276	704	2640	198	396
Dinobryon sp	475	466	371	912	323	304	57	190
Asterionella gracillima	0	128	576	512	288	640	0	352
Cyclotella sp	0	0	0	0	0	0	0	0
Cymbella sp	0	0	0	0	0	0	0	0
Diatoma sp	0	0	0	0	0	0	0	0
Fragilaria sp	0	0	0	0	0	0	0	195
Fragilaria crotonensis	0	0	0	0	224	192	0	0
Melosira sp	0	0	0	0	0	0	0	350
Melosira granulata	0	0	0	954	0	0	0	0
Navicula sp	0	0	0	0	0	0	0	0
Pennales	500	50	250	300	650	0	400	0
Rhizosolenia sp	900	150	300	600	450	900	0	0
Rhoicosphenia curvata	0	0	0	0	0	0	0	127
Stephanodiscus sp	17	9	0	17	9	34	9	17
Stephanodiscus binderanus	0	0	0	0	0	0	0	0
Stephanodiscus niagarae	0	0	0	0	0	0	0	0
Tabellaria sp	0	0	0	0	0	0	0	0
Tabellaria fenestrata	500	0	0	0	0	250	3000	0
Synedra sp	0	0	0	0	0	0	0	50

APPENDIX 2

SEPTEMBER 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MGP/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	884	2301	351	2678	3796	1976	163	442
Oscillatoria sp	0	0	0	0	0	0	0	0
Aphanizomenon flos-aquae	165	1020	261	535	125	1092	74	86
Microcystis sp	0	0	80	0	0	0	138	80
Merismopedia sp	0	0	0	0	0	0	0	0
Ankistrodesmus falcatus	0	0	0	0	0	0	0	0
Ankistrodesmus mirabilis	0	0	0	0	0	0	0	0
Cosmarium sp	0	0	0	0	0	0	0	0
Elakatothrix gelatinosa	0	0	0	0	0	0	0	10
Oocystis sp	0	0	0	0	0	0	0	0
Scenedesmus bijuga	0	0	16	0	0	0	8	0
Closterium sp	0	0	0	0	0	0	0	0
Kirchneriella sp	0	0	0	0	0	0	0	0
Franceia	0	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	0	0	0
Mougeotia sp	0	0	0	0	0	0	0	0
Crucigenia sp	21	0	14	0	0	14	0	7
Lagerheimia sp	0	0	0	0	0	0	0	0
Selanastrum sp	0	0	0	0	0	0	0	0
Golenkinia sp	0	0	0	0	0	0	0	0
Tetraedron sp	0	0	0	0	0	0	0	0
Peridinium sp	0	0	0	0	0	0	0	0
Ceratium hirundinella	0	0	0	0	0	0	0	0
Cryptomonas sp	4224	2816	1056	2112	10208	15840	880	10208
Rhodomonas minuta	1496	770	902	1276	1474	990	308	1760
Dinobryon sp	19	342	646	836	38	57	76	0
Asterionella gracillima	448	64	128	768	1152	1984	0	640
Cyclotella sp	0	0	0	0	0	0	0	0
Cymbella sp	0	0	0	0	0	0	0	0
Diatoma sp	0	0	0	0	0	0	0	0
Fragilaria sp	135	0	0	0	105	0	0	0
Fragilaria crotonensis	0	0	0	0	96	112	0	0
Melosira sp	0	0	0	0	0	0	0	0
Melosira granulata	0	0	0	0	0	0	0	0
Navicula sp	0	0	0	0	0	0	0	0
Pennales	200	0	100	100	100	300	400	500
Rhizosolenia sp	600	0	300	300	1800	900	1200	1500
Rhoicosphenia curvata	0	0	0	0	0	0	0	0
Stephanodiscus sp	60	17	17	26	26	51	0	128
Stephanodiscus binderanus	1050	600	600	1050	6150	0	2550	1200
Stephanodiscus niagarae	4148	0	0	2074	2074	0	0	0
Tabellaria sp	0	0	0	0	0	0	0	0
Tabellaria fenestrata	2500	0	0	1250	0	0	5875	0
Synedra sp	100	0	0	100	0	0	0	0

APPENDIX 2

OCTOBER 1987 ATIKOKAN PHYTOPLANKTON BIOMASS (MG/M3)

	ICY	ANDERSON DAM	MARMION NORTH	MARMION SOUTH	ABIE	MOOSE	SLUSH	SNOW
Anabaena sp	0	0	0	130	0	325	533	0
Oscillatoria sp	0	0	0	0	0	0	0	0
Aphanizomenon flos-aquae	149	670	264	693	353	416	908	396
Microcystis sp	72	0	0	0	32	0	336	0
Merismopedia sp	0	0	0	0	0	0	0	0
Ankistrodesmus falcatus	8	0	0	15	30	0	0	0
Ankistrodesmus mirabilis	0	0	0	0	0	0	0	0
Cosmarium sp	0	0	0	0	0	0	660	0
Elakatothrix gelatinosa	0	10	10	0	0	0	20	0
Oocystis sp	50	0	250	0	0	0	200	0
Scenedesmus bijuga	0	0	0	0	0	8	0	0
Closterium sp	0	0	0	0	0	0	0	0
Kirchneriella sp	0	0	0	0	0	0	0	0
Franceia	0	0	0	0	0	0	0	0
Pediastrum sp	0	0	0	0	0	0	0	0
Mougeotia sp	0	0	0	0	0	0	0	0
Crucigenia sp	0	0	0	0	14	0	0	14
Lagerheimia sp	0	0	0	0	0	0	0	0
Selenastrum sp	0	0	0	0	0	0	0	0
Golenkinia sp	0	0	0	0	0	0	0	0
Tetraedron sp	0	0	380	0	0	0	190	0
Peridinium sp	0	0	0	0	0	0	1660	0
Ceratium hirundinella	0	0	0	0	0	0	0	0
Cryptomonas sp	8448	2816	4576	4576	8096	3520	3872	9152
Rhodomonas minuta	1078	550	616	814	1188	462	264	1430
Dinobryon sp	29	133	76	38	38	29	76	76
Asterionella gracillima	704	704	704	512	1024	416	0	640
Cyclotella sp	0	0	0	0	0	0	0	0
Cymbella sp	0	0	0	0	0	0	0	0
Diatoma sp	0	0	0	263	0	0	0	0
Fragilaria sp	0	90	0	4650	0	0	0	0
Fragilaria crotonensis	64	0	0	0	400	0	0	0
Melosira sp	0	0	0	0	0	0	0	0
Melosira granulata	318	7314	14628	4770	10494	795	0	0
Navicula sp	0	0	0	0	0	0	0	0
Pennales	200	0	500	0	200	0	1400	100
Rhizosolenia sp	450	300	900	0	1500	150	0	0
Rhoicosphenia curvata	0	0	0	0	0	0	0	0
Stephanodiscus sp	38	34	34	26	26	4	9	9
Stephanodiscus binderanus	0	450	2400	43500	0	0	0	0
Stephanodiscus niagarae	0	4148	4148	0	2074	0	0	0
Tabellaria sp	0	0	0	0	0	0	0	100
Tabellaria fenestrata	875	2250	1500	6250	750	0	5000	750
Synedra sp	50	0	0	100	0	0	0	0

APPENDIX 3

May-October 1987
Atikokan Zooplankton Densities (No/m^3)

APPENDIX 3

MAY 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

MAY 29, 1987	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum			592		2222		404	
Holopedium gibberum		202	446			1482		4848
Daphnia longiremis		404			1818	3952	2020	2828
Daphnia retrocurva			888	468	1010	4446	3232	3636
Ceriodaphnia spp			370	234	606	494		
Daphnia spp	606	1616	814	702	1818	11362	5252	3232
Daphnia ambigua								
Chydorus spp								
Bosmina longirostris	1515	2424		2574	1414	32604	16968	19796
Eubosmina corigoni	1414	2626	1776			1482	5656	1212
Alona								
Daphnia galeata mendotae	707	1818	296					
Chydorus sphaericus								
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	2929	3030	4218	4212	4040	10868	14140	18988
Diaptomus minutus								
Diaptomus ashlandi								
Calanoid nauplii	15352	10908	3848	14976	9494	23712	18988	30704
Calanoid copepodites	1515	2222	1998	3978	1616	1976	7676	10504
Diaptomus siciloides								
Limnocalanus macrurus								
Eurytemora affinis								
Epischura lacustris								
Cyclops bicuspidatus thomasi	1919	5252	5624	7488	6060	10868	22220	20200
Cyclops vernalis					202			
Mesocyclops edax		4242						
Cylopoid nauplii	8585	6868	2664	6552	6666	8398	9696	10504
Cyclopoid copepodites	909	2626	3034	4680	3030	4940	8080	19796
Tropocyclops prasinus								

APPENDIX 3 (CONT'D)

MAY 29, 1987	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp				1170		4940		
Brachionus clayciflorus			148	936				
Keratella cochlearis	7979	59590	46620	144846	94940	492024	200384	329664
Keratella hiemalis								
Keratella quadrata	1111	8686	1332		8484	6916	3232	5252
Notholca sp								
Notholca acuminata				234				
Kellicottia longispina	39895	84840	30118	117000	135138	82004	119584	158368
Lepadella spp		606		468				
Lecane spp								
Lecane luna								
Lecane lunaris								
Trichocerca spp		404		468	808			
Trichocerca cylindrica				1170			2020	1212
Trichocerca multicrinis			148			6422		
Trichocerca similis								
Trichocerca porcellus								
Trichocerca longiseta								
Euchlanis dialatata							1212	
Asplanchna spp	2323	6666	1850	6786	8080	46930	3636	8888
Polyarthra spp	5959	20604	15688	936	57570	32604	43228	55348
Synchaeta spp	303	808	592	468	1212	2470		
Ploesoma spp								
Ploesoma triacanthum								
Filinia longiseta	404	3434		9828	69892	4446		3636
Conochilus unicornis	1313	1414						
Gastropus spp	505	3030	666	1170	2424	11362	1212	2020
Trochosphaera								
Collotheca sp								
Collotheca pellagica				468				
Ascomorpha sp								
Unknown rotifer	101	202	296	702	1212	1976	1212	1212

APPENDIX 3

JUNE 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

JUNE 24	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum			1480	936	1616	1976	1166	1212
Holopedium gibberum	1818	1616	3256	6552	2020	988	1272	1616
Daphnia longiremis	1010	5656	740	2340	12524	1976	424	606
Daphnia retrocurva	3030	2020	5328	13572	20200	15314	4346	20402
Ceriodaphnia spp	2020			1404			318	
Daphnia spp	1212	2020	444	3978	5252	3952	1060	2626
Daphnia ambigua		808	444	234	1616			808
Chydorus spp	202							
Bosmina longirostris	1212	3636	3552	5616	2828	1976	4028	4040
Eubosmina corigoni					2020			
Alona					404			
Daphnia galeata mendotae			444				106	1010
Chydorus sphaericus								
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	6666	5656	3996	4212	4848	4446	1484	4242
Diaptomus minutus	404						530	606
Diaptomus ashlandi							106	1010
Calanoid nauplii	11110	47268	5772	18720	38784	19266	15158	16564
Calanoid copepodites	4848	3636	1628	5148	6868	2470	4982	4646
Diaptomus siciloides								
Limnocalanus macrurus			296					
Eurytemora affinis								
Epischura lacustris								
Cyclops bicuspidatus thomasi	1414	4444	3552	10764	10100	5434	3710	6464
Cyclops vernalis					404	988		404
Mesocyclops edax								
Cyclopoid nauplii	9090	37572	7252	17316	15756	12350	17172	16564
Cyclopoid copepodites	3636	5656	2664	7254	7676	4446	5618	4646
Tropocyclops prasinus								

APPENDIX 3 (CONT'D)

JUNE 24	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp								
Brachionus calyciflorus								
Keratella cochlearis	19796	63832	15688	80262	47268	87932	44838	38380
Keratella hiemalis								
Keratella quadrata		12524	740		7272	1976	742	1818
Notholca sp								
Notholca acuminata	606		592	936	1616	1976	212	202
Kellicottia longispina	17574	73932	15096	15912	19796	88892	6254	9494
Lepadella spp						2964		
Lecane spp		808						
Lecane luna								
Lecane lunaris							318	
Trichocerca spp				702				
Trichocerca cylindrica	1818	1212			808	1482	106	
Trichocerca multicrinis			444	4914		4940	1166	404
Trichocerca similis							106	
Trichocerca porcellus								
Trichocerca longiseta	1212	1616		702	5656	1482		
Euchlanis dialatata								
Asplanchna spp	1010	37976	2368	8424	17776	40014	1908	2828
Polyarthra spp	5050	15756	3256	16146	18180	16302	9328	13130
Synchaeta spp	808	3232	1480	702	3232	2470		1616
Ploesoma spp						2470		
Ploesoma triacanthum								404
Filinia longiseta		3232	3700		7272	1482		
Conochilus unicornis	404			702	404	494	212	1010
Gastropus spp	2828	10908	3108	5616	4848	1976	1802	2626
Trochosphaera					3232	5928		
Collotheca sp								
Collotheca pellagica								
Ascomorpha sp								
Unknown rotifer	808	1616	444	936	2020	2964	424	808

APPENDIX 3

JULY 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

JULY 22	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum	340	17	168	120	3636	315	81	136
Holopedium gibberum	85	51		64	1818	21		
Daphnia longiremis	17	17				21		
Daphnia retrocurva	238	170	144	208	4444	147	45	85
Ceriodaphnia spp		51	24	16	4040		18	85
Daphnia spp	136	68	72		1010		81	51
Daphnia ambigua								
Chydorus spp	340							
Bosmina longirostris	289	187	120	192	1414	210	297	459
Eubosmina corigoni								
Alona								
Daphnia galeata mendotae			12		404			
Chydorus sphaericus								
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	680	85	240	184	3636	126	108	153
Diaptomus minutus			12		404	42		51
Diaptomus ashlandi				16				51
Calanoid nauplii	901	1411	660	496	25654	1302	657	1037
Calanoid copepodites	153	102	60	144	6666	210	81	289
Diaptomus siciloides								
Limnocalanus macrurus		17						
Eurytemora affinis								
Epischura lacustris								
Cyclops bicuspidatus thomasi	714	323	360	424	7070	714	378	272
Cyclops vernalis			12	8	202			102
Mesocyclops edax				32				
Cyclopoid nauplii	1071	1394	468	600	36562	1869	567	799
Cyclopoid copepodites	459	136	108	184	5454	504	162	289
Tropocyclops prasinus								

APPENDIX 3 (CONT'D)

JULY 22	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp								
Brachionus clayciflorus		17						
Keratella cochlearis	1173	3485	1644	1240	106050	6153	4293	4539
Keratella hiemalis								
Keratella quadrata	17	17	24		202	42		
Notholoca spp							9	
Notholca acuminata								
Kellicottia longispina	1037	323	216	136	10504	147	81	357
Lepadella spp								
Lecane spp	17							
Lecane luna								
Lecane lunaris						21		
Trichocerca spp								
Trichocerca cylindrica			24			21		
Trichocerca multicrinis		85	12	64	2424	609	162	119
Trichocerca similis								
Trichocerca porcellus								
Trichocerca longiseta		85		32	2626		9	
Euchlanis dialatata								
Asplanchna spp	153	187	204	24	6666	63	180	68
Polyarthra spp	816	1343	900	760	3552	2226	3204	3179
Synchaeta spp	17	51	12	16	404	21		85
Ploesoma spp						21		
Ploesoma triacanthum								
Filinia longiseta			108	144	1818			51
Conochilus unicornis	68		24	16		21		
Gastropus spp	204	357	336	88	3838	462	666	969
Trochosphaera sp		34						
Collotheca spp	136							
Collotheca pellagica								
Ascomorpha sp								
Unknown rotifer	68	85	96	32	1414	147	45	

APPENDIX 3

AUGUST 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

AUGUST 10	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum	119	272	468	578	204	441	288	306
Holopedium gibberum			60	119				
Daphnia longiremis		17						
Daphnia retrocurva	34	238	96	170	34	63	36	34
Ceriodaphnia spp		102		51	34	42	36	51
Daphnia spp		34		34	17	42	45	17
Daphnia ambigua								
Chydorus spp		34		68			54	
Bosmina longirostris	136	442	336	476	255	315	450	544
Eubosmina corigoni								
Alona								
Daphnia galeata mendotae								
Chydorus sphaericus	493							
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	68	289	108	102	17	21	45	51
Diaptomus minutus	51	51	24			42	99	
Diaptomus ashlandi	51		168	34			9	
Calanoid nauplii	374	1411	1260	1717	935	1281	2025	867
Calanoid copepodites	221	561	204	459	357	294	612	221
Diaptomus siciloides								
Limnocalanus macrurus						42		85
Eurytemora affinis							18	
Epischura lacustris							27	
Cyclops bicuspidatus thomasi	170	204	312	527	289	252	522	136
Cyclops vernalis	68	170	36	289	102	231	54	510
Mesocyclops edax								
Cyclopoid nauplii	238	1326	600	1054	1173	819	1314	901
Cyclopoid copepodites	323	833	276	527	442	231	675	323
Tropocyclops prasinus								

APPENDIX 3 (CONT'D)

AUGUST 10	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp			24					
Brachionus calyciflorus								
Keratella cochlearis	1462	4080	2040	4896	4794	8400	4392	3196
Keratella hiemalis								
Keratella quadrata								
Notholca sp								
Notholca acuminata								
Kellicottia longispina	255	323	192	238	306	147	189	119
Lepadella spp								
Lecane sp								
Lecane luna								51
Lecane lunaris							18	
Trichocerca spp								34
Trichocerca cylindrica	170				153	42		34
Trichocerca multicrinis	34	68	24	136	68	462	135	68
Trichocerca similis								
Trichocerca porcellus								
Trichocerca longiseta	34	442	108	34	306			
Euchlanis dialatata								
Asplanchna spp	34	85	60	187	459	231	54	221
Polyarthra spp	323	1258	1080	1105	2057	1323	2124	2057
Synchaeta spp		51	48			84		
Ploesoma spp								
Ploesoma triacanthum								
Filinia longiseta		51	84	34	85	63	108	51
Conochilus unicornis	17		60	51	51		27	34
Gastropus spp	153		84	527	561	399	99	204
Trochosphaera sp								
Collotheca sp								
Collotheca pellagica								
Ascomorpha sp								
Unknown rotifer	51	68	48	34	136	63	99	51

APPENDIX 3

SEPTEMBER 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

SEPTEMBER 29	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum		102	72	N	102	231	45	68
Holopedium gibberum			192	O	85		45	
Daphnia longiremis								
Daphnia retrocurva	34	68	192	S	85	168	81	119
Ceriodaphnia spp		340	24	A	51	210		187
Daphnia spp				M				
Daphnia ambigua				P				
Chydorus spp	136	51	36	L	170		18	
Bosmina longirostris	170	595	204	E	1479	1323	405	782
Eubosmina corigoni								
Alona								
Daphnia galeata mendotae								
Chydorus sphaericus								
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	51	34	36		34	105	63	
Diaptomus minutus		34	12				27	
Diaptomus ashlandi		17	24		51	21		
Calanoid nauplii	51	544	156		119	168	72	187
Calanoid copepodites	17	34	48		34	105	36	85
Diaptomus siciloides								
Limnocalanus macrurus								
Eurytemora affinis								
Epischura lacustris								
Cyclops bicuspidatus thomasi	51	136	108		238	273	198	34
Cyclops vernalis	306	374	420		221	735	612	799
Mesocyclops edax	51							
Cyclopoid nauplii	85	612			544	189	153	255
Cyclopoid copepodites	34	102			102	252	99	136
Tropocyclops prasinus			108				54	102

APPENDIX 3 (CONT'D)

SEPTEMBER 29	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp					51			
Brachionus calyciflorus								
Keratella cochlearis	2482	5882	1632		9707	4725	2844	7497
Keratella hiemalis								
Keratella quadrata	51							
Notholca sp								
Notholca acuminata								
Kellicottia longispina	238	238	72		255		153	238
Lepadella spp								
Lecane spp								
Lecane luna								
Lecane lunaris		34						34
Trichocerca spp								
Trichocerca cylindrica			60		51		36	
Trichocerca multicrinis		102	84		136	42	36	34
Trichocerca similis								
Trichocerca porcellus								
Trichocerca longiseta	187	187	48		340	336	36	102
Euchlanis dialatata								
Asplanchna spp	68	901	336		493	945	144	
Polyarthra spp	136	1105	996		391	672	207	136
Synchaeta spp	34	561	84		204	420	27	102
Ploesoma spp		51			34			
Ploesoma triacanthum								
Filinia longiseta	68							
Conochilus unicornis			84			42		34
Gastropus spp	459	340	240		238	189	63	629
Trochosphaera sp					255	399		
Collotheca sp								
Collotheca pellagica								901
Ascomorpha spp								
Unknown rotifer	102	119	60		102	126		102

APPENDIX 3

OCTOBER 1987 ATIKOKAN ZOOPLANKTON DENSITIES (NO/M3)

OCTOBER 24	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
CLADOCERA								
Diaphanosoma leuchtenbergianum			36	33	34	105	18	17
Holopedium gibberum			12					
Daphnia longiremis		34	48	55	68			
Daphnia retrocurva	34	170	144	99	51	42	54	68
Ceriodaphnia spp		34		55	51	63	54	34
Daphnia spp							9	
Daphnia ambigua								
Chydorus spp	34	85		121	51	126		68
Bosmina longirostris	629	799	348	814	459	210	1350	1054
Eubosmina corigoni								
Alona								
Daphnia galeata mendotae						63		34
Chydorus sphaericus								
COPEPODA								
Senecella calanoides								
Diaptomus oregonensis	34	51	60	33	34	84	45	
Diaptomus minutus								
Diaptomus ashlandi			24	11				34
Calanoide nauplii		170	204	671	289	525	81	136
Calanoid copepodites	34	85	36	55	51	105	9	34
Diaptomus siciloides	34	34			51			
Limnocalanus macrurus					34			
Eurytemora affinis								
Epischura lacustris								
Cyclops bicuspidatus thomasi	34	34	72	176	34	189	81	34
Cyclops vernalis	119	187	372	187	272	441	198	289
Mesocyclops edax							9	68
Cyclopoid nauplii	51	357	240	550	391	714	117	204
Cyclopoid copepodites	34	153	96	55	85	168	63	85
Tropocyclops prasinus								

APPENDIX 3 (CONT'D)

OCTOBER 24	Slush Lake	Snow Lake	Marmion North	Marmion South	Icy Lake	Abie Lake	Moose Lake	Anderson Dam
ROTIFERA								
Brachionus spp								
Brachionus clayciflorus								
Keratella cochlearis	1853	4590	2472	5577	6205	6888	3429	5678
Keratella hiemalis								
Keratella quadrata								
Notholca sp								
Notholca acuminata								
Kellicottia longispina	204	238	132	154	238	357	189	238
Lepadella spp								
Lecane spp								
Lecane luna								
Lecane lunaris		34						
Trichocerca spp								
Trichocerca cylindrica			12		34		9	
Trichocerca multicrinis		34	24	121	17	105	45	
Trichocerca similis								
Trichocerca porcellus	187	51			68			
Trichocerca longiseta	153		60					34
Euchlanis dialatata								
Asplanchna spp	85	136	228	297	238	399	99	85
Polyarthra spp	34	204	252	154	51	126	189	204
Synchaeta spp	85	289	324	352	595	735	225	
Ploesoma spp								
Ploesoma triacanthum								
Filinia longiseta		34		33		63		
Conochilus unicornis							18	
Gastropus spp	34	34	252	220	102	294	63	85
Trochosphaera				22				
Collotheca sp								
Collotheca pellagica								
Ascomorpha sp								
Unknown rotifer	119	68	48	33	102	105	18	68

APPENDIX 4

Scientific and Common Names of Macrophytes Cited in the Text
(from Fassett 1975)

APPENDIX 4

Scientific and Common Names of Macrophytes Cited in the Text
(from Fassett 1975)

Scientific Name	Common Name
Beckmannia syzigachne	Slough Grass
Brasenia schreberi	Water Shield
Calamagrostis canadensis	Bluejoint
Callitriche hermaphrodite	Water Starwort
C. heterophylla	Water Starwort
Ceratophyllum demersum	Coontail
Chamaedaphne calyculata	Leatherleaf
Dulichium arundinaceum	Three-way Sedge
Eleocharis acicularis	Needle Rush
E. paulustris	Creeping Spike Rush
Elodea canadensis	Waterweed
Equisetum sp	Scouring Rush (Horsetail)
Eriocaulon septangulare	Pipewort
Glyceria borealis	Manna Grass
G. canadensis	Rattlesnake Manna Grass
G. grandis	Reed Meadow Grass
Hippurus vulgaris	Mare's Tail
Iris sp	Iris
Juncus effusus	Soft Rush
Lemna sp	Duckweed
Lobelia dortmonna	Water Lobelia
Megalodonta beckii	Water Marigold
Mimmulus ringens	Monkey Flower
Myriophyllum alterniflorus	Water Milfoil
M. exalbescens	Water Milfoil
Najas flexilis	Bushy Pondweed
Nuphar sp	Yellow Water Lily
Nymphaea odorata	Water Lily
Polygonum natans	Smartweed
Potamogeton alpinus	-
P. amplifolius	Large-leaf Pondweed (Muskie, Bass Weed)
P. epihydrus	Leafy Pondweed
P. foliosus	Leafy Pondweed
P. friesii	-
P. gramineus	Variable Pondweed
P. natans	Floating Brownleaf (Floating-leaf Pondweed)
P. obtusifolius	-
P. pectinatus	Sago Pondweed
P. praelongus	-
P. pusillus	-
P. richardsonii	Clasping-leafed Pondweed (Bass Weed)

P. robbinsii	Robbin's Pondweed
P. spirillus	-
P. strictifolius	-
P. vaseyi	-
P. zosteriformis	Flat-stemmed Pondweed
Ranunculus tricophyllus	Buttercup (Crowfoot)
Rorippa islandica	Cress
Sagittaria sp	Arrowhead (Duck Potato)
Scirpus cyperinus	Bulrush
S. validus	Softstem Bulrush (Great Bulrush)
Sium suave	Water Parsnip
Sparganium fluctuans	Floating-leaf Bur Reed (Broad Ribbon-leaf)
Typha spp	Cattail
Utricularia vulgaris	Bladderwort
Vallisneria americana	Wild Celery (Tape Grass)

APPENDIX 5

Macrophyte Species Observed Along Transects Selected for Special Study, 1987

APPENDIX 5
MACROPHYTE SPECIES OBSERVED ALONG TRANSECTS
SELECTED FOR SPECIAL STUDY, 1987

APPENDIX 5
MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN SNOW LAKE IN 1987

TRANSECTS	1	2	3	4
Chara sp	X	X	X	X
Elodea canadensis	X	X	X	X
Megalodonta beckii		X	X	X
Myriophyllum exalbescence	X	X	X	X
Najas flexilis		X		
Potamogeton amplifolius	X	X	X	X
P. epihydrus	X			
P. epihydrus			X	X
P. foliosus		X		
P. gramineus		X		
P. pusillus	X	X	X	X
P. richardsonii	X	X	X	X
P. robbinsii	X	X	X	X
P. spirillus		X		
P. strictifolius		X		
Scirpus spp	X	X	X	X
Typha spp	X	X	X	X

APPENDIX 5

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN WEST BAY OF ICY LAKE IN 1987

TRANSECT	1	2	3	4	5	6	7	16	17
Callitriche hermaphroditica					X	X			
Chara sp					X				X
Elodea canadensis					X	X			X
Megalodonta beckii	X	X	X	X	X	X	X	X	X
Myriophyllum exalbescens	X	X			X	X	X	X	X
Najas flexilis					X	X			
Nymphaea odorata	X								
Potamogeton epihydrus					X	X			
P. friesii					X	X			
P. natans	X								
P. pusillus					X		X		
P. richardsonii			X	X	X	X	X	X	X
P. robbinsii	X	X	X	X	X	X	X	X	X
P. spirillus					X	X			
P. strictifolius					X	X			
P. zosteriformis					X				
Ranunculus tricophyllus					X	X			
Sagittaria spp	X								
Scirpus spp	X				X	X	X	X	
Sparganium fluctuans	X								
Typha spp	X				X	X	X	X	
Vallisneria americana							X		

APPENDIX 5

MACROPHYTE SPECIES PRESENT ON TRANSECTS IN EAST BAY OF ICY LAKE IN 1987

TRANSECTS	8	9	10	11	12	13	14	15
Elodea canadensis							X	X
Megalodonta beckii							X	X
Myriophyllum exalbescens	X	X	X	X	X	X		
Najas flexilis	X	X	X	X	X	X	X	X
Nymphaea odorata	X			X	X		X	
Potamogeton amplifolius							X	X
P. friesii							X	X
P. praelongus							X	X
P. pusillus	X	X	X	X	X	X		
P. robbinsii	X	X	X	X	X	X	X	X
P. zosteriformis							X	X
Scirpus spp	X	X					X	
Typha spp	X	X					X	
Vallisneria americana							X	X

APPENDIX 5

MACROPHYTE SPECIES PRESENT ON TRANSECTS IN ABIE LAKE IN 1987

TRANSECT	1	2	3	4
Brasenia schreberi		X	X	X
Chara sp	X	X		
Elodea canadensis	X		X	X
Megalodonta beckii	X	X	X	X
Myriophyllum alterniflorum	X		X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata	X	X	X	X
Polygonum natans		X	X	X
Potamogeton epihydrus	X			
P. gramineus	X		X	X
P. pusillus		X		
P. richardsonii	X		X	X
P. robbinsii	X	X	X	X
Sagittaria spp	X	X	X	X
Scirpus spp	X		X	X
Typha spp	X		X	X
Utricularia vulgaris		X		
Vallisneria americana		X		

APPENDIX 5

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN MARMION LAKE NEAR ABIE IN 1987

TRANSECT	1	2	3
Callitriche hermaphroditica		X	
Chamaedaphne calyculata		X	X
Chara sp	X		
Elodea canadensis	X	X	X
Juncus effusus		X	
Myriophyllum alterniflorum	X	X	X
Myriophyllum exalbescens	X	X	X
Najas flexilis	X	X	X
Nymphaea odorata	X	X	
Potamogeton amplifolius	X	X	
P. epihydrus	X		
P. gramineus		X	
P. richardsonii	X	X	X
P. robbinsii	X	X	X
P. spirillus	X		
P. zosteriformis	X	X	X
Sagittaria spp		X	X
Scirpus spp		X	X

APPENDIX 5

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN MARMION LAKE AT ANDERSON DAM IN 1987

TRANSECT	1	2	3	4
Callitriche hermophroditica	X	X	X	X
Ceratophyllum demersum	X	X	X	X
Chara sp	X	X	X	X
Eleocharis acicularis				X
Elodea canadensis	X	X	X	X
Glyceria borealis				X
Juncus effusus				X
Myriophyllum alterniflorum	X	X	X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata				X
Potamogeton epihydrus	X	X	X	X
P. gramineus				X
P. praelongus	X	X	X	X
P. pusillus				X
P. richardsonii	X	X	X	X
P. spirillus				X
P. zosteriformis	X	X	X	X
Ranunculus tricophulllus	X	X	X	X
Sagittaria spp				X
Scirpus spp				X
Typha spp				X

APPENDIX 6

Macrophyte Species Observed Along Transects Selected for Special Study, 1988

APPENDIX 6
MACROPHYTE SPECIES OBSERVED ALONG TRANSECTS
SELECTED FOR SPECIAL STUDY, 1988

APPENDIX 6
MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN SNOW LAKE IN 1988

TRANSECTS	1	2	3	4
Chara sp		X		
Elodea canadensis	X	X	X	X
Megalodonta beckii			X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Potamogeton amplifolius	X	X	X	X
P. epihydrus	X		X	X
P. foliosus	X	X		
P. friesii	X		X	X
P. pusillus	X	X	X	X
P. richardsonii	X	X	X	X
P. robbinsii	X	X	X	X
Scirpus spp	X	X	X	X
Typha spp	X	X	X	X

APPENDIX 6

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN WEST BAY OF ICY LAKE IN 1988

TRANSECT	1	2	3	4	5	6	7	16	17
Brasenia schreberi						X	X		
Callitriche hermaphroditica					X	X			
Chara sp				X	X			X	X
Elodea canadensis				X	X	X	X	X	X
Megalodonta beckii	X	X	X	X	X	X	X	X	X
Myriophyllum exalbescens	X	X	X	X	X	X	X	X	X
Najas flexilis				X	X	X		X	X
Nymphaea odorata	X					X	X		
Potamogeton epihydrus					X	X			
P. friesii							X		X
P. pusillus				X	X		X	X	X
P. richardsonii				X	X	X	X	X	X
P. robbinsii	X	X	X	X	X	X	X	X	X
P. zosteriformis				X	X		X	X	
Ranunculus trichophyllus					X	X			
Sagittaria spp	X				X	X	X	X	
Scirpus spp	X				X	X	X	X	
Sparganium fluctuans	X				X	X	X	X	
Typha	X				X	X	X	X	
Vallisneria americana					X		X		

APPENDIX 6

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN EAST BAY OF ICY LAKE IN 1988

TRANSECTS	8	9	10	11	12	13	14	15
Brasenia schreberi	X	X		X	X		X	
Elodea canadensis							X	X
Equisetum sp	X	X		X	X		X	
Megalodonta beckii							X	X
Myriophyllum exalbescens	X	X	X	X	X	X	X	X
Najas flexilis	X	X	X	X	X	X	X	X
Nymphaea odorata	X	X		X	X		X	
Potamogeton amplifolius							X	X
P. foliosus	X	X	X	X	X	X	X	X
P. friesii							X	X
P. natans							X	X
P. praelongus							X	X
P. pusillus	X	X	X	X	X	X	X	X
P. richardsonii							X	X
P. robbinsii	X	X	X	X	X	X	X	X
P. zosteriformis							X	X
Sagittaria spp	X	X		X	X		X	
Scirpus spp	X	X	X				X	X
Sparganium fluctuans	X	X		X	X		X	
Typha spp	X	X	X				X	X
Vallisneria americana							X	X

APPENDIX 6

MACROPHYTE SPECIES PRESENT ON TRANSECTS IN ABIE LAKE IN 1988

TRANSECT	1	2	3	4
Brasenia schreberi		X	X	X
Chara sp	X	X		
Elodea canadensis	X		X	X
Megalodonta beckii	X	X	X	X
Myriophyllum alterniflorum	X		X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata	X	X	X	X
Polygonum natans		X	X	X
Potamogeton epihydrus	X			
P. gramineus	X		X	X
P. pusillus		X		
P. richardsonii	X		X	X
P. robbinsii	X	X	X	X
Sagittaria spp	X	X	X	X
Scirpus spp	X		X	X
Typha spp	X		X	X
Utricularia vulgaris		X		
Vallisneria americana		X		

APPENDIX 6

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN MARMION LAKE NEAR ABIE IN 1988

TRANSECT	1	2	3
Callitriche hermaphroditica		X	
Chamaedaphne calyculata		X	X
Chara sp	X		
Elodea canadensis	X	X	X
Juncus effusus		X	
Myriophyllum alterniflorum	X	X	X
Myriophyllum exalbescens	X	X	X
Najas flexilis	X	X	X
Nymphaea odorata	X	X	
Potamogeton amplifolius	X	X	
P. epihydrus	X		
P. gramineus		X	
P. richardsonii	X	X	X
P. robbinsii	X	X	X
P. spirillus	X		
P. zosteriformis	X	X	X
Sagittaria spp		X	X
Scirpus spp		X	X

APPENDIX 6

MACROPHYTE SPECIES PRESENT ALONG TRANSECTS IN MARMION LAKE AT ANDERSON DAM IN 1988

TRANSECT	1	2	3	4
Callitriche hermophroditica	X	X	X	X
Ceratophyllum demersum	X	X	X	X
Chara sp	X	X	X	X
Eleocharis acicularis				X
Elodea canadensis	X	X	X	X
Glyceria borealis				X
Juncus effusus				X
Myriophyllum alterniflorum	X	X	X	X
Myriophyllum exalbescens	X	X	X	X
Najas flexilis	X	X	X	X
Nymphaea odorata				X
Potamogeton epihydrus	X	X	X	X
P. gramineus				X
P. praelongus	X	X	X	X
P. pusillus				X
P. richardsonii	X	X	X	X
P. spirillus				X
P. zosteriformis	X	X	X	X
Ranunculus tricophulllus	X	X	X	X
Sagittaria spp				X
Scirpus spp				X
Typha spp				X